

A FLORISTIC STUDY OF VOLCÁN MOMBACHO DEPARTMENT OF GRANADA, NICARAGUA¹

JOHN T. ATWOOD²

ABSTRACT

Volcán Mombacho is a moderate sized (1,345 m elev.), quiescent volcano with one of two cloud forests in southwestern Nicaragua. Of 457 species listed, 80 are pteridophytes and 87 are orchids. The species richness of these groups may be accounted for by their high fecundity and dispersibility. This study has revealed only one endemic species. Since Mombacho is the apparent northern range limit of several orchid species, it is suggested that the flora of the cloud forest has most of its affinities with Costa Rica. The lack of several wide ranging species on Mombacho which are known only as far south as northern Nicaragua further supports this contention. As with most of tropical America, the cloud forests of Mombacho are threatened by exploitation of their natural resources.

Volcán Mombacho (Fig. 1) is a quiescent, much eroded, and well vegetated volcano located near the city of Granada, Nicaragua. "Mombacho" is a modification of the Nahuatl "Mopachotepetl" meaning "inclined mountain" (Mantica, 1973). It is located at 11°50'N latitude, 85°59'W longitude (see map, Fig. 2), and is the fifth largest of the quaternary volcanos in western Nicaragua forming a chain from El Salvador to Costa Rica (Mooser et al., 1958). With a maximum elevation of 1,345 m, Mombacho is somewhat lower than several other Nicaraguan volcanos, the highest of which is 1,745 m. It is, however, perhaps the most massive with a basal diameter of about 7 km. Its U-shaped crater rim is 1.5 km in diameter and the crater floor is about 750 m lower than the highest peak. The lowest point on the crater rim is 1,080 m.

Besides the highest peak of the southeast crater rim, there is a second peak on the northwest rim with an elevation of 1,222 m. Adjacent to this peak is a large flat area appropriately called "Plan de las Flores." Within this area are two small vegetated craters each of unknown depth and about 200 m in diameter. Eastward from Plan de las Flores lies a trough-shaped valley over 1.5 km across extending northeast from the crater rim for a distance of 3.5 km.

Aerial photographs reveal a number of lava flows extending down the sides of Mombacho, but these features have been obscured in the northeast valley and the open south side of the crater rim by later seismic events. The lava flows are for the most part fully vegetated, and their basal limits are sharply defined where they meet pastured savannas.

Certain areas, notably the flanks of the crater rim and the sides of the valley extending northeastward, are precipitous. These areas, often with a slope well over 100 percent, are mostly vegetated, but frequent landslides have left conspicuous scars and a jagged crater rim.

Very few permanent streams can be found on Mombacho, although stream beds occur in various ravines filled only during times of heavy precipitation. Most of the precipitation seeps down through the loose volcanic substrate, leaving little runoff. Because of the porous substrate, the two craters at Plan de las Flores do not contain lakes.

Viewed from Granada, Mombacho appears as a rich green, broadly truncated, and much eroded volcanic cone. It is most impressive in cloudless late afternoons, when the various physical features cast shadows pointing up the rough topography. A number of cut-over areas mar the slopes

¹ I wish to thank J. Incer B., C. Gutierrez H., and Universidad Centroamericana for laboratory and field assistance. Thanks are also extended to D. A. Neill for assistance in field work, and to F. C. Seymour for his support and use of his herbarium. For various determinations gratitude is extended to the following: J. H. Beaman, W. E. Burger, T. B. Croat, C. H. Dodson, M. J. Donoghue, H. Kennedy, D. B. Lellinger, R. McVaugh, H. N. Moldenke, F. C. Seymour, L. B. Smith, W. D. Stevens, H. Wiehler, and J. J. Wurdack. However, I assume full responsibility for the determinations. For guidance in this research I thank J. H. Beaman of the Department of Botany and Plant Pathology, Michigan State University. I thank T. B. Croat and W. D. Stevens for their comments on and suggested revisions to the manuscript. This paper is based on a thesis completed at Michigan State University in 1976 under J. H. Beaman.

² Marie Selby Botanical Gardens, 811 South Palm Avenue, Sarasota, Florida 33577.

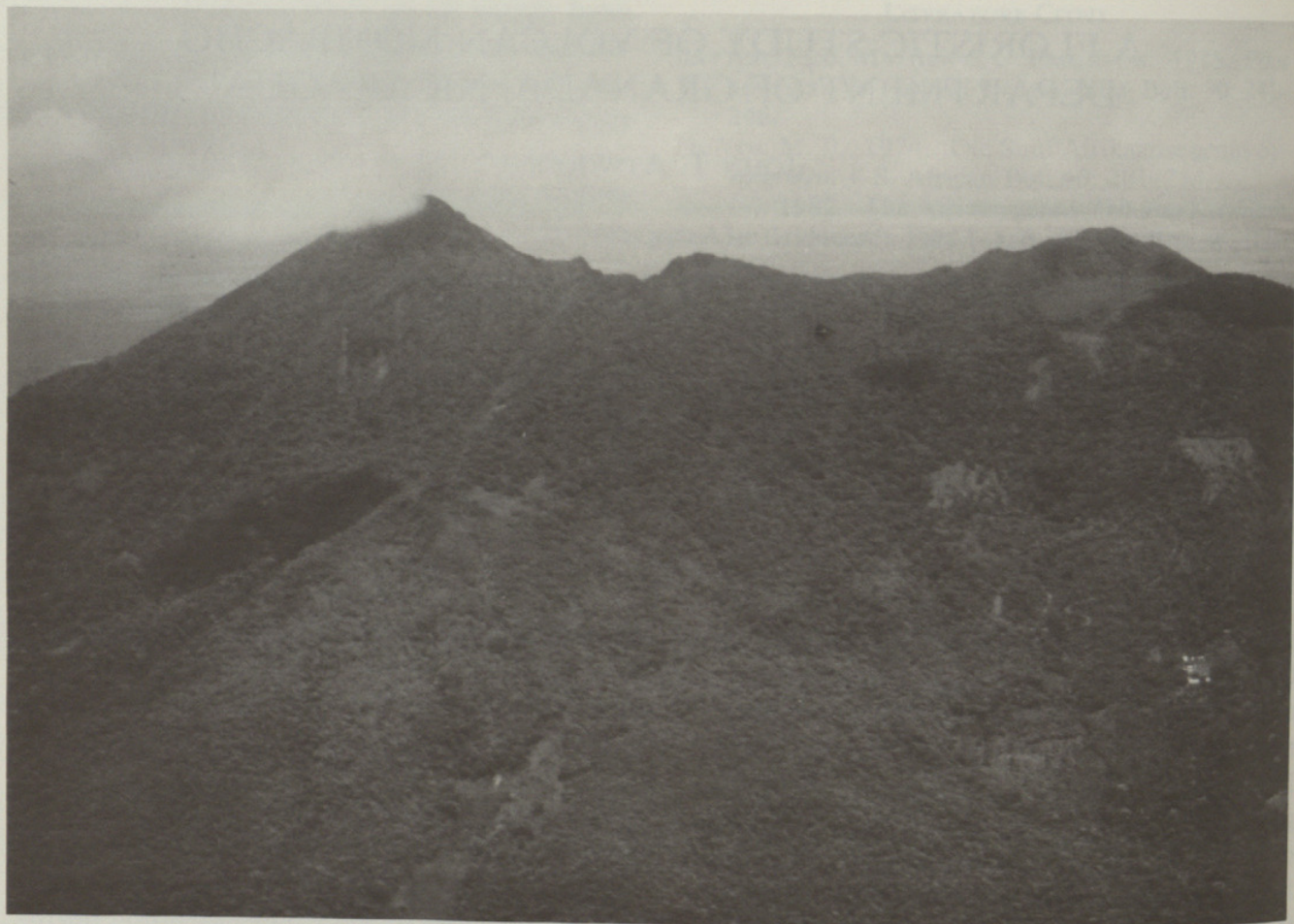


FIGURE 1. Profile view of Mombacho from the north.

and much of the lower areas have been deforested or severely disturbed.

Everywhere in the tropics the mountain forests are disappearing at alarming rates. It is hoped that interest in the flora of this mountain will help bring an awareness by government officials that the development of the Nicaraguan cloud forests is not in their best interests.

Volcán Mombacho was selected partly because it contains a substantial amount of extant virgin forest and, because being close to urban areas, it has educational, recreational, and economic potential. For these reasons it seemed that a survey of the flora of this volcano would be a greater contribution than a similar work on a more remote mountain. Collections made specifically for this work were made during the months of May through July 1975 and February and March 1977. The most complete set of voucher specimens has been deposited in the Beal-Darlington Herbarium of Michigan State University.

GEOLOGICAL HISTORY

Mombacho's violent past is reflected in the size of the crater and the general topography.

Little is known of its geological history, but a few seismic events have been documented since the time of the Spanish conquest.

As a member of the west Nicaraguan volcanic chain Mombacho is probably not older than two million years and may be considerably younger. Mooser et al. (1958) reported that the most recent authenticated eruption occurred in 1560, but this report is not supported by Incer (pers. comm.). Incer (1973) indicated that during the same century the south crater rim avalanched away, causing the destruction of the south flank and an Indian village of 400 inhabitants. Crawford (1902) reported that an eruption occurred in 1850, but Mooser et al. (1958) also indicated that a small parasitic cone called "Pilas" formed on the north flank of Mombacho in 1850, but this report is probably confused with the eruption of a mountain north of Lake Nicaragua by the same name. However, a small cone northeast of Mombacho may have been active in historic times.

The uniform texture of the crater walls suggests that in its early development Mombacho was built up primarily from ash rather than lava flows. The ash probably formed a volcanic cone similar

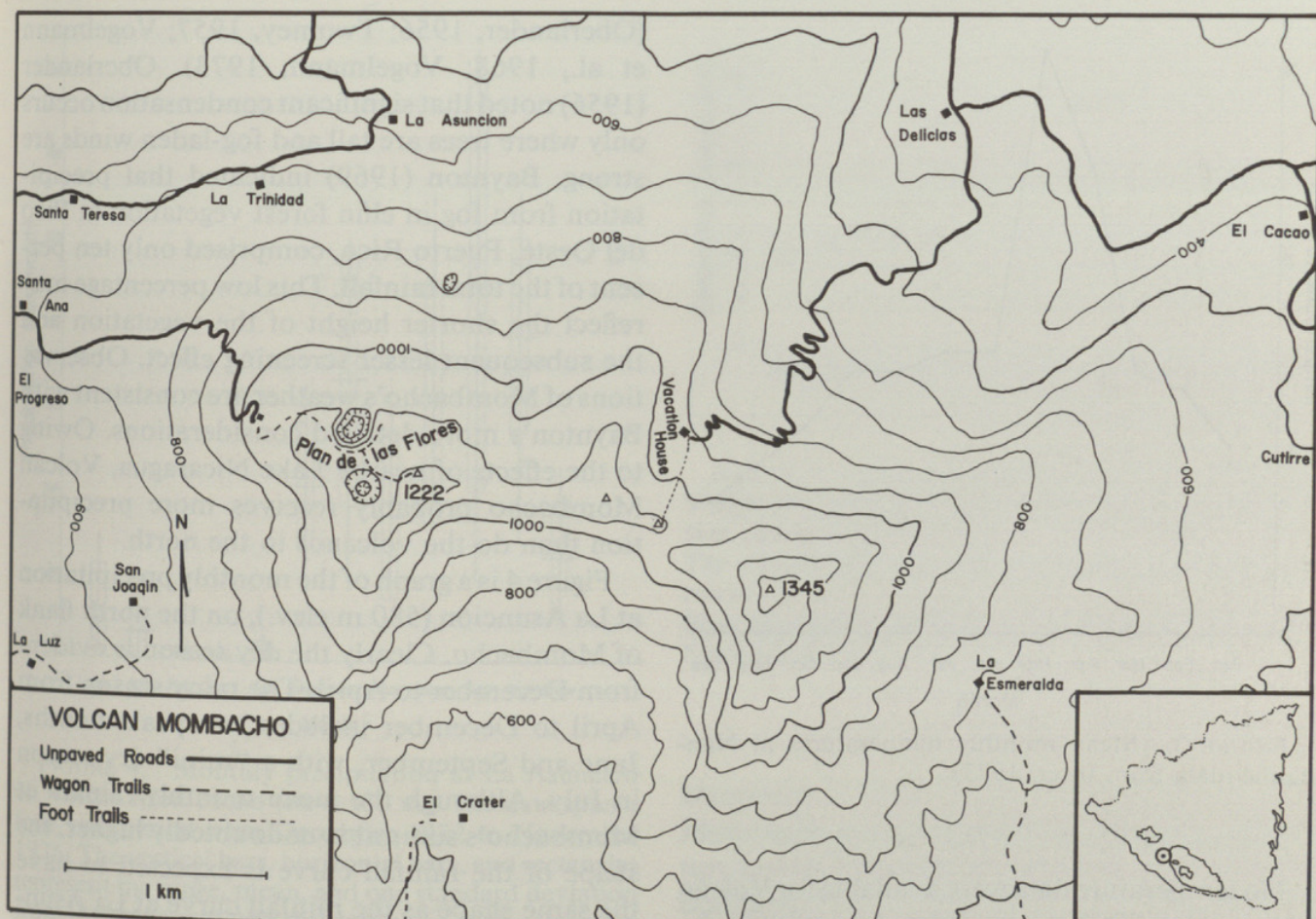


FIGURE 2. Map of Volcán Mombacho (after Hoja 3051 III and Hoja 3051 IV published by Instituto Geografica Nacional and Servicio Geodesico Interamericano, 1972 edition, scale 1 : 50,000).

to Mombotombo to the north and Concepción to the south. If lines following the existing flanks of Mombacho are projected upward, they meet at about 2,000 m (Incer, 1973), a possible elevation that Mombacho may have attained in its geological past. Apparently the more recent volcanism was manifested as lava flows, which seem to nearly cover the surface of the mountain.

It is not clear exactly how the crater was formed, but the very steep sides suggest that an internal collapse occurred, caused by subsiding lava not by an explosion similar to that which took place on Krakatoa. The two craters at Plan de las Flores apparently were formed by collapse (Incer, pers. comm.).

Exactly which events took place in the sixteenth century causing the destruction of the south crater wall is not clear, but it is known that a lake once occurred within the crater (Incer, 1973). Apparently the loose substrate collapsed under its own weight and pressure from the crater lake, but the ultimate avalanche was probably precipitated by an earthquake. A similar event probably occurred much earlier on the northeast flank, leaving a trough shaped valley. Since the six-

teenth century, Mombacho has remained relatively quiet, but the rough topography and fumaroles of the crater rim attest to its violent past.

CLIMATE

The climate of lowland Pacific slope Nicaragua and the lower slopes of Volcán Mombacho may be described as "tropical dry." No single mean monthly temperature below 17.1°C has been determined at stations reported by Incer (1973). The widest range of variation of monthly means for any station is less than 4°C. However, Incer (1973) indicated that the daily temperature at Managua (with an annual mean of 26.3°C) may deviate at least 7.3°, because a temperature of 19°C in January has been recorded. The temperature therefore fluctuates little throughout the year. After the rains cease in December a dry season ensues with essentially no rainfall in the lowlands until May. This period of drought roughly corresponds to the winter season of the north. Because rainfall is much more abundant, the climate of the summit is moister and cooler, with swift gusty winds as attested by frequent blow-downs.

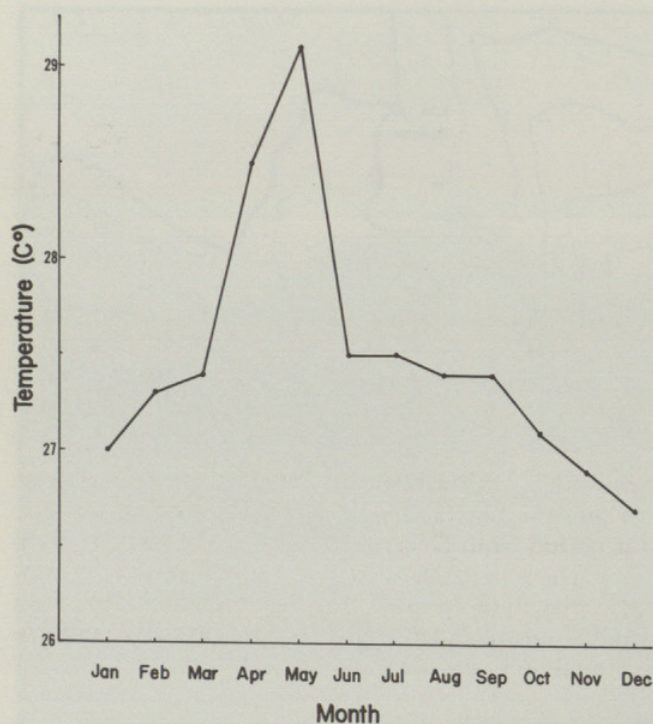


FIGURE 3. Mean monthly temperatures at Nandaime (data from Incer, 1973).

No temperature data were available for Volcán Mombacho, but data were taken from the nearby village of Nandaime (Incer, 1973), which lies 12 km southwest of the volcano at 150 m elevation (Fig. 3). To estimate the mean annual temperature of Mombacho's summit (ca. 1,200 m elev.) the mean dry and wet adiabatic rates were applied to the data from Nandaime. If the dry adiabatic rate of 1°C per 100 m (Strahler, 1973) is applied to the mean annual temperature at Nandaime (27.5°C), the mean annual temperature at the level of 1,200 m could be depressed 10.5° to a minimum 17°C . The wet adiabatic rate of 0.6°C per 100 m would depress the mean annual temperature 6.3°C to 21.2°C . Thus the calculated range of mean annual temperature falls between 17°C and 21.2°C . To estimate the minimum temperature at 1,200 m the dry adiabatic rate can be applied to the minimum temperature at Managua (19°C at 50 m elev.). The estimated temperature difference between the two elevations is 11.5°C , therefore the temperatures at Mombacho's summit could drop to 7.5°C . Clearly, if frost ever occurs at the summit, it must be a rare event.

The forests become increasingly wet with elevation. Not only is there more convectional and orographic rainfall, but also the dense vegetation behaves as a screen, filtering moisture from passing fog, as has been noted on other mountains

(Oberlander, 1956; Twomey, 1957; Vogelmann et al., 1968; Vogelmann, 1973). Oberlander (1956) noted that significant condensation occurs only where trees are tall and fog-laden winds are strong. Baynton (1969) indicated that precipitation from fog in elfin forest vegetation at Pico del Oeste, Puerto Rico, comprised only ten percent of the total rainfall. This low percentage may reflect the shorter height of the vegetation and the subsequent lesser screening effect. Observations of Mombacho's weather are consistent with Baynton's more detailed considerations. Owing to the effects of nearby Lake Nicaragua, Volcán Mombacho probably receives more precipitation than do the volcanos to the north.

Figure 4 is a graph of the monthly precipitation at La Asunción (580 m elev.), on the north flank of Mombacho. Clearly the dry season is evident from December to April. The rainy season from April to December includes two peak months, June and September, with a "mini" dry season in July. Although the mean monthly rainfall at Mombacho's summit is undoubtedly higher, the shape of the rainfall curve is expected to have the same shape as the rainfall curve at La Asunción.

Rainfall undoubtedly varies locally with the slope. Clouds on the windward side move parallel with the slope, but move vertically when approaching essentially vertical cliffs. With vertical air movement a corresponding higher local precipitation is expected.

Figure 5 includes histograms of monthly evaporation at La Asunción. It shows that the period from March to May is the driest, corresponding to the period of maximal temperature at Nandaime.

The rapid changes of climatic factors at the summit are striking. Rapidly moving fog can disappear, revealing the full force of the sun only for the pattern to be repeated with a sudden blanket of fog. Such changes in the weather may have a considerable effect on the vegetation.

A BRIEF ACCOUNT OF THE VEGETATION

For purposes of this study it seems most natural and convenient to divide Mombacho into three altitudinal vegetation zones. For the lowest zone continuous throughout western lowland Nicaragua the term "deciduous seasonal forest" of Beard (1942, 1944) seems most appropriate, reflecting the deciduous nature of the vegetation as affected by seasonal rainfall. The second zone

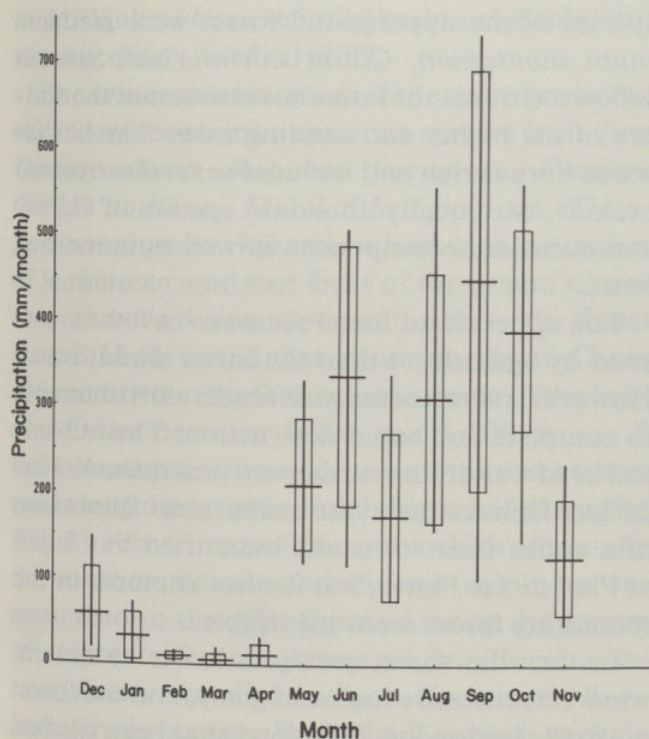


FIGURE 4. Monthly precipitation at La Asunción on Volcán Mombacho (elev. 580 m). The data span a four year period from December 1972 to November 1976. The vertical bars, horizontal bars, and rectangles represent the range, mean, and one standard deviation from the mean respectively (data provided by Empresa Nacional de Luz y Fuerza).

is here termed the "cloud forest." The cloud forests of Mombacho are evergreen and distinct from the deciduous forest. The third and highest vegetational zone, also often beclouded, is the "elfin forest" characterized by stunted trees to about 8 m tall.

The deciduous seasonal forest during the rainy season is very similar in appearance to the tropical rain forest. Even the stately emergent *Ceiba* is common to both forests in Nicaragua, although it usually does not gain its greatest stature in the deciduous forest. When the rains cease in December the forest becomes leafless, and several genera initiate flowering (*Plumeria*, *Byrsonima*, *Cochlospermum*), lending color to the otherwise drab landscape.

The shrubby layer includes *Casearia*, *Karwinskia*, and several vines of the families Convolvulaceae, Bignoniaceae, Solanaceae, Aristolochiaceae, Cucurbitaceae, and Vitaceae. This layer is usually torched by landowners to rid grazing areas of undesirable weeds and ticks. Because of the great demands made upon the deciduous seasonal forest by man, very little can be found in a natural state, and essentially none on Volcán

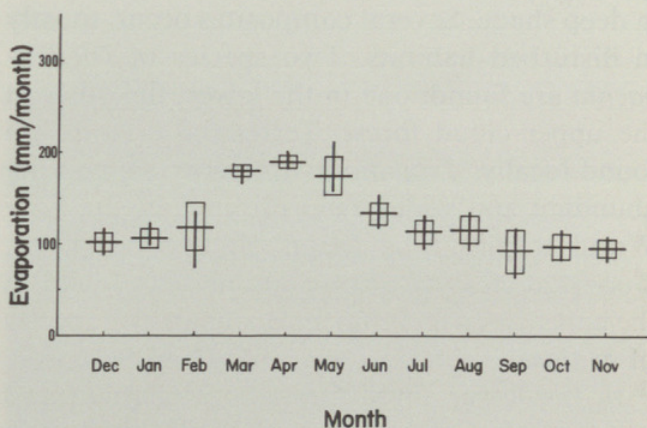


FIGURE 5. Monthly evaporation at La Asunción on Volcán Mombacho (elev. 580 m). The data span a four year period from December 1972 to November 1976. The vertical bars, horizontal bars, and rectangles represent the range, mean, and one standard deviation from the mean respectively (data provided by Empresa Nacional de Luz y Fuerza).

Mombacho. Most of the forests surrounding Mombacho were probably converted to agriculture by native Americans long before the Spanish conquest.

Mombacho contains one of two cloud forests in southwestern Nicaragua; the other occurring on Volcán Maderas. The Mombacho cloud forest extends from approximately 400 m elevation on the east-northeast flank nearly to the summit. It begins considerably higher on the south-southwest flank, owing to the rain shadow. The cloud forest is characterized by evergreens and generally lush vegetation, a manifestation of the abundant precipitation. The many shades of green of the cloud forest indicate a complex aggregation of species, but this diversity diminishes with increasing elevation.

The tallest trees are to be found in the lower cloud forest, and the forest becomes shorter with elevation until the dwarfing effect culminates at the elfin forest.

Characteristic of the cloud forest is the presence of masses of epiphytes representing a number of plant groups. Many epiphytic ferns of several families occur as do members of the angiosperm families Bromeliaceae, Gesneriaceae, Piperaceae, Araceae, Lentibulariaceae, and Ericaceae, but by far the most species rich family is the Orchidaceae, although it is low in biomass.

The herbaceous flora of the cloud forest is characterized by pteridophytes. A grass, *Oplismenus* was observed to occur in areas of moderate shade in the upper cloud forest, but never

in deep shade. Several composites occur, mostly in disturbed habitats. Two species of *Dieffenbachia* are found; one in the lower, the other in the upper cloud forest. Terrestrial orchids are found locally. *Tropidia polystachya*, supposedly abundant and widespread in much of the New World tropics, was found on two occasions. *Goodyera* cf. *bradeorum* is more often found in the upper cloud and elfin forests, as are two species of *Malaxis*.

In the lower cloud forest both vascular and non-vascular epiphytes are relatively uncommon on the lower portions of trees but occur in large numbers in the canopy. Most epiphytes were collected from trees that had fallen or were felled, but undoubtedly many more species remain uncollected. Several bromeliads and orchids in this area, such as *Guzmania lingulata*, *Tillandsia schiediana*, *Trigonidium egertonianum*, *Nidema boothii*, and *Encyclia fragrans*, are also common to lowland rain forests of the Zelaya Department. Two common epiphytic aroid species, *Anthurium scandens* and *A. cubense* are most abundant in this zone, the latter occurring in the marginal areas with the deciduous forest.

The shrub layer of the lower cloud forest includes the urticaceous *Urera*, but probably the Piperaceae is best represented here. *Pothomorphe* was collected with various species of *Piper* in disturbed areas, but other species of *Piper* were found in the darkest understory. In the lower cloud forest of the east slope, *Carica papaya* was observed to assume a dominant position in the understory.

A number of pioneer and adventive species were collected in disturbed areas, and many were undoubtedly dispersed by man. Among the more attractive is *Mirabilis jalapa*, a common weed of coffee plantations.

The lower cloud forest is the most disturbed zone of evergreen vegetation, and the little remaining primary forest is threatened. The best examples of extant lower cloud forest seem to be in the northeast facing valley above Finca Las Delicias. However, agriculture here is showing its effects because most of the primary lower cloud forest has either been removed or severely disturbed.

The upper cloud forest is characterized by a low, few-layered canopy lacking distinct crowns. The trees are often conspicuously covered with vascular and non-vascular epiphytes even to the base of their trunks, and the light intensity at the ground level is much higher than that of the lower cloud forest. Three commonly observed tree

species of the upper cloud forest were *Hedyosmum montanum*, *Clusia salvinii*, and *Senecio arborescens*, but the latter never assumes the stature of the higher surrounding trees. The herbaceous flora is rich and includes several terrestrial orchids, two locally abundant species of *Carex*, and occasional composites as well as numerous ferns.

The upper cloud forest seems to be less threatened by agriculture than the lower cloud forest. However, its restricted size renders it vulnerable to complete and rapid destruction. The tell-tale tracks of wandering cattle were noted above Finca Las Delicias near the crater rim. Expansion of a coffee plantation was once tried but failed at Plan de las Flores, but further attempts in the remaining forest seem inevitable.

In the elfin forest precipitation is abundant, wind velocities are high and gusty, and the forest is usually beclouded. Elfin forest has been studied by a number of investigators. Brown (1919) investigated an elfin forest (mossy forest) on Mount Maquiling on the island of Luzon, Philippines. Beard (1942, 1944) studied elfin forests in the Antilles, and Steenis (1972) noted the elfin forests of Java. Detailed investigations have been conducted at Pico del Oeste, Puerto Rico by Howard (1968, 1969) and Gill (1969). Alvarez del Castillo (1976) contributed an ecological and floristic work on an elfin forest on Volcán San Martín Tuxtla, Veracruz, Mexico.

Beard (1944) characterized the elfin forest of the Caribbean area as an "open woodland about 8 m high of stunted, gnarled trees, often stilt-rooted and with thick fleshy leaves, with long rambling branches pointing away from the wind. There may be an understory of dwarf palms and tree ferns. The whole is loaded with moss, lichens, and epiphytes, and forms a completely impenetrable thicket."

Viewed from the air, the elfin forest of Volcán Mombacho appears as an even, dense canopy pruned by the elements. The upper cloud forest lacks the pruned appearance, and the line delimiting the two forests is often distinct. The canopy consists of one stratum beneath which are occasional shrubs (especially *Psychotria* spp.), and numerous herbs. Nearly every branch is inhabited by bryophytes, and epiphytic vascular plants are common everywhere. The leaves of arboreal elfin forest species with few exceptions tend to be leathery, entire, and small to medium-sized. Aerial photographs show that the elfin forests of Mombacho extend along all exposed ridges and pinnacles down to an elevation of about 900

m. It blankets even the roughest topography, including nearly vertical cliffs.

The arborescent stratum of the more protected elfin forest contains numerous species including *Clusia salvinii*, *Rapanea ferruginea*, *Freziera friedrichstaliana*, *Myrcianthes fragrans*, *Oreopanax xalapense*, *Viburnum hartwegii*, a number of Rubiaceae, and tree ferns of the genera *Cyanthea* and *Nephelea*. Concerning the elfin forest Beard (1944) noted that "pure stands of *Clusia* spp. constitute this formation in some of the lesser Antilles between 1,000 and 1,100 m" Pure stands of *Clusia* occur on Mombacho, but only along the most exposed ridges and pinnacles (Fig. 6). Ferns, bromeliads, and orchids are among the most numerous and diverse epiphytes encountered in the elfin forest. Among the genera of epiphytic ferns represented are *Elaphoglossum*, *Grammitis*, *Polypodium*, *Hymenophyllum*, and *Trichomanes*. Bromeliad genera include *Aechmea*, *Guzmania*, *Pitcairnia*, *Tillandsia*, and *Vriesia*.

The terrestrial herbaceous stratum is expectedly rich. In the shaded area of the mature elfin forest the terrestrial herbaceous flora consists largely of ferns. An absence of grasses was noted, but *Oplismenus hirtellus* forms mats in open areas. Three species of Cyperaceae, *Carex donnell-smithii*, *C. polystachya*, and *Uncinaria hamata*, occur frequently in the elfin forest, often along damp and exposed banks. The terrestrial orchid inhabitants include *Malaxis maxonii*, *M. tipuloides*, *Erythroides* spp., *Goodyera bradeorum*, and *Psilochilus* cf. *macrophyllus*. One terrestrial gesneriad, *Kohleria spicata*, is commonly found along the access roads to Plan de las Flores.

The herbaceous flora of disturbed areas varies with locality. The herbs of the disturbed crater rim consist almost exclusively of *Isachne arundinacea* with a scattering of weedy composites. *Arundinella deppeana* is the most characteristic grass of disturbed Plan de las Flores. Other herbs including *Castilleja arvense*, several composites, and the ferns *Phlebodium aureum* and *Ophioglossum reticulatum* occur in open areas.

It is noted that a shrubby layer is often lacking especially in the elfin forests dominated by *Clusia*. In the more diverse elfin forest are shrubby *Psychotria* spp. and a bristly melastome, *Clidemia* (?) sp. The diversity of shrubs of disturbed areas is much higher, except along the crater rim where *Rubus* is most abundant. At Plan de las Flores the open disturbed area once cleared for coffee growing consists of a large number of shrubs and herbs. Among the shrubby species are *Con-*



FIGURE 6. View of the highest peak of Mombacho with *Clusia* thicket in the foreground.

ostegia spp., *Monochaetum deppeanum*, *Ardisia* sp., *Parathesis* sp., *Viburnum hartwegii*, and *Cestrum aurantiacum*.

At least four alien floristic elements were observed at Plan de las Flores. *Hippeastrum* sp. was observed and collected once. A row of *Hibiscus rosa-sinensis* was observed in the abandoned clearing as were *Coffea arabica* and occasional clumps of *Musa paradisiaca*. Among a large number of pioneer species and weeds found in the disturbed area of the cloud forest above Finca Las Delicias was a cultivated *Coccoloba uvifera*. None of the once cultivated elements found seemed to be reproducing and no juvenile individuals were observed. Occasional waifs from lower elevations, such as *Mormodes* sp. and *Jacquinella globosa*, were found in the elfin forest.

HISTORICAL SKETCH OF BOTANICAL EXPLORATION ON VOLCÁN MOMBACHO

The first pioneer traveler and naturalist known to make collections on Volcán Mombacho was Emanuel Ritter Friedrichstal. His travels included the Antilles, Nicaragua, Guatemala, and the Yucatan, from 1837 to 1841 (Allgemeine Deutsche Biographie, 1878). It is probable that several Friedrichstal specimens attributed to Guatemala actually took their origin in Nicaragua, as may be the case with *Freziera friedrichstaliana* known only from Mombacho (Kobuski, 1941), and Honduras (Melina, 1975), and not from Guatemala (Standley & Williams, 1961).

Anders Sandøe Oersted visited Mombacho in December of 1847 (fide F. Seymour, pers. comm.). He also collected *Heliocarpus nodiflorus* (Lay, 1949) and it is probable that he collected many more specimens.

Kobuski (1941) noted that G. Wright collected

Freziera friedrichstaliana on Volcán Mombacho.

Paul Levy, a French engineer, resided in Granada and collected Nicaraguan plants between 1869 and 1885 (Hemsley, 1887; Chaudhri et al., 1972), but if he made collections from Mombacho none of his specimens have surfaced.

Charles Fuller Baker, graduate of Michigan Agricultural College in 1891 (Cattell, 1906) made collections on Mombacho in February of 1903 (from herbarium sheet, *Baker 2488*, MSC).

In 1909 the first of two volumes of "Flora Nicaraguense" by Miguel Ramirez Goyena was published, and to this day it remains the sole flora of the area. Goyena doubtless botanized Mombacho, but nothing is known of his collecting there. Unfortunately his work cites no specimens, and only a few localities, so its utility is limited.

W. R. Maxon, A. D. Harvey, and A. T. Valentine visited Mombacho in July 1923. They collected a new species of *Malaxis* that Oakes Ames named *M. maxonii* (Ames, 1923).

Verne Grant collected on Mombacho in 1940 and 1941 (fide F. Seymour & F. Almeda, pers. comm.).

In January 1967 L. O. Williams, Antonio Melina R., and A. H. Heller collected there during a three-day period (Heller, pers. comm.). A. D. Moore, D. A. Dudey, and Charles Nichols collected on the southeastern slope on January 9, 1969. Much of the material for this work comes from their collections.

On January 27 of the following year Edwardo Narvaez S. and I collected in the disturbed area around the vacation house above Finca Las Delicias.

On April 9, 1971, I collected about 30 numbers from the elfin forest on the northwest crater rim.

In May 1972 R. L. Wilbur, D. E. Stone, and F. Almeda made collections near the crater (F. Almeda, pers. comm.).

Frank C. Seymour made collections on July 25, 1972 and also on August 1 of the same year with Stuart B. Robbins.

David A. Neill, Stephan A. Marshall, and I collected around the north and northwest crater rim in December 1973 and January 1974.

THE FLORA

Many of the collections in the following checklist were difficult to determine owing to lack of revisionary work. As monographic treatments are produced for various genera, many names in-

cluded here will be found to be incorrect. The checklist is complete to 1980, but additional species have since been collected by W. D. Stevens.

A set of specimens collected in 1975 and 1977 was left at Universidad Centroamericana (UCA) at Managua, but the principal set of 1975 collections is contained in the Beal-Darlington Herbarium (MSC) of Michigan State University. These latter collections are preceded by A (Atwood), N (Neill), or AN (Atwood & Neill). Most of the specimens collected before 1975 by F. Seymour, D. Dudey, D. Moore, C. Nichols, S. Robbins, E. Narvaez S., D. Neill, A. Marshall, and me were owned by Mr. Frank Seymour, who kindly provided me access to his herbarium. This collection is now incorporated at the Missouri Botanical Garden (MO).

The classification of the fern families adopted here is authored by Crabbe et al. (1975). The classification of the angiosperm families is basically that of Cronquist (1968).

A total of 457 species are represented in the checklist, including 80 species of pteridophytes distributed among 15 families and 33 genera, and 377 species of angiosperms representing 90 families and 256 genera. No gymnosperms are known from Mombacho. The largest fern families are the Aspleniaceae and Polypodiaceae with 24 and 16 species respectively. The largest angiosperm families are the Orchidaceae and Compositae with 87 and 29 species respectively.

It is unwise to speculate on the phytogeographic significance of most floristic elements of Mombacho because the species and their ranges are poorly known. Nevertheless several observations concerning phytogeography seem justified.

The large numbers of pteridophyte and orchid species are probably in part accounted for by their high fecundity and dispersibility. However, it is curious that the Gesneriaceae, also highly fecund and supposedly easily dispersed, is represented by only three species.

Five epiphytic orchids find their northernmost limits on Mombacho or central Nicaragua. These include: *Epidendrum lacustre*, *E. selaginella*, *Mesospinidium warscewiczii*, and *Pleurothallis convallaria*. The northerly range limits of these orchids and the absence of *Carpinus*, *Liquidambar*, and *Pinus* suggest that the flora is Costa Rican.

One endemic and one near endemic species are noted for Volcán Mombacho. The first species is *Maxillaria mombachoensis* (Orchidaceae), an

attractive orange orchid of the *Maxillaria cucullata* complex and the second, *Freziera friedrichstaliana* (Theaceae), known otherwise only from Honduras.

LIST OF SPECIES

FERNS AND FERN ALLIES

ADIANTACEAE

- Adiantum concinnum* Willd. Robbins 6254, 1 August 1972 (MO). Lower cloud forest.
- A. lunulatum* (Roxb.) Burm. f. Atwood 77120a, 8 February 1977 (MSC). Very local in lower cloud forest.
- A. macrophyllum* Sw. Atwood A48, 30 April 1975 (MSC). Common in lower cloud forest.
- A. trapeziforme* L. Atwood 77105, 8 February 1977 (FSU, MO, MSC). Local in lower cloud forest.
- Pityrogramma calomelanos* L. Seymour 6099, 25 July 1972 (MO). Locally abundant in cloud forest.
- P. ferruginea* (Kunze) Maxon. Atwood 3899, 27 January 1970 (MO). Apparently uncommon in cloud forest.
- Pteris altissima* Poir. Atwood 3909, 27 January 1970 (VT). Lower cloud forest.
- Vittaria* cf. *remota* Fee. Atwood 7742, 3 February 1977 (FSU, MSC). Common elfin forest epiphyte.

ASPLENIACEAE

- Asplenium abscissum* Willd. Neill N40, 29 April 1975 (MSC); Atwood A170, 15 May 1975 (MSC). Local on crater rim and at Plan de las Flores.
- A. cristatum* Lam. Atwood & Neill AN197, 16 July 1975 (MSC). Lower and upper cloud forests.
- A. formosum* Willd. Dudgey & Moore 1966, 9 January 1969 (MO); Atwood & Neill AN93, 2 July 1975 (MSC). Rare lithophyte on border of deciduous forest and cloud forest at Finca Las Delicias.
- A. cf. fragrans* Sw. Dudgey & Moore 1966a, 9 January 1969 (MO).
- A. hoffmanni* Hieron. Atwood & Neill AN57, 1 July 1975 (MSC). Lower cloud forest.
- A. pteropus* Kaulf. Atwood A13, 29 April 1975 (MSC). Near northeast crater rim in elfin forest. Growing as an epiphyte.
- A. cf. pulchellum* Raddi. Atwood 3911, 27 January 1970 (MSC). Lower cloud forest.
- A. radicans* var. *partitum* (Klotzsch) Hieron. Atwood 7776, 6 February 1977 (MSC). Rare epiphyte of upper cloud forest.
- Bolbitis cladorhizans* (Sprengel) Ching. Dudgey & Moore 1968, 9 January 1969 (MO). Lower cloud forest above Finca Las Delicias.
- Ctenitis hemsleyana* (Baker ex Hems.) Copel. Atwood 77157, 15 February 1977 (FSU). Locally common in shaded understory of elfin forest.
- C. subincisa* (Willd.) Ching. Atwood & Neill AN190, 16 July 1975 (MSC). Upper cloud forest.
- Diplazium cristatum* (Desr.) Alson. Atwood A304, 5 June 1975 (MSC). Common in elfin forest.
- D. shepherdii* (Sprengel) Link. Atwood 3907, 27 January 1969 (VT). Lower cloud forest.
- D. striatastrum* Lellinger. Atwood, Marshall & Neill 6727, 16 December 1973 (MO). Cloud forest.
- Dryopteris karwinskyana* (Mett.) Kuntze. Atwood

77156, 10 February 1977 (FSU, MSC). Locally common in elfin forest.

Elaphoglossum furfuraceum Christ. Atwood 5451, 9 April 1971 (VT). Elfin forest.

E. palmense Christ. Neill N41, 29 April 1975 (MSC); Atwood A308, 5 June 1975 (MSC); Atwood & Neill AN196, 16 July 1975 (MSC). Local epiphyte of upper cloud and elfin forests.

E. tectum (H. B. ex Willd.) Moore? Atwood, Marshall & Neill 6724, 16 December 1973 (MO). Apparently uncommon epiphyte of upper cloud and elfin forests.

E. sp. Atwood A30, 29 April 1975 (MSC); Atwood A302, 5 June 1975 (MSC). Elfin forest epiphyte at Plan de las Flores. Other species of *Elaphoglossum* undoubtedly occur on Volcán Mombacho.

Peltapteris peltata (Sw.) Morton. Atwood 3913, 27 January 1970 (MO); Atwood, Marshall & Neill 6707, 15 December 1973 (MO).

Polybotrya cervina (L.) Kaulf. Atwood & Neill AN200, 16 July 1975 (MSC). Upper cloud forest on east flank.

Polystichopsis pubescens (L.) Morton. Atwood 3908, 27 January 1970 (MO).

Tectaria heracleifolia (Willd.) Underw. Atwood 77109, 8 February 1977 (MSC). Uncommon terrestrial of lower cloud forest.

T. mexicana (Fee) Morton. Atwood 77144, 10 February 1977 (MSC, SEL). Lower cloud forest.

BLECHNACEAE

Blechnum cf. *divergens* (Kunze) Mett. Atwood A42, 30 April 1975 (MSC). Upper cloud and elfin forest terrestrial. This may be the same as *B. ensiforme*.

B. ensiforme (Liebm.) C. Chr. Atwood, Marshall & Neill 6731, 16 December 1973 (MO); Neill N39, 29 April 1975 (MSC). Upper cloud and elfin forest.

B. fragile (Liebm.) Morton & Lellinger. Atwood, Marshall & Neill 6730, 16 December 1973 (MO). Upper cloud and elfin forest.

B. lehmannii Hieron. Atwood A292, 5 June 1975 (MSC). Common terrestrial in shade of elfin forest.

B. occidentale L. Dudgey & Moore 1965, 9 January 1969 (MO). Frequent in cloud and elfin forest.

B. pyramidatum (Lam.) Urb. Nichols 2005, 9 January 1969 (MO).

B. unilaterale Sw. Atwood 77168, 15 February 1977 (MSC). Local on eroded banks of upper cloud forest.

CYATHEACEAE

Cyathea sp. Atwood A298a, 5 June 1975 (MSC). Tree fern common at Plan de las Flores.

Nephelea mexicana (Schlecht. & Cham.) Tryon. Atwood A344, 10 July 1975 (MSC). Tree of elfin forest. Common locally.

DAVALLIACEAE

Nephrolepis pectinata (Willd.) Schott. Atwood A14, 29 April 1975 (MSC). Locally common in upper cloud forest about 900 m.

GLEICHENIACEAE

Gleichenia bifida (Willd.) Sprengel. Atwood A17, 29 April 1975 (MSC). Common fern of disturbed areas of crater rim and elfin forest. Often produces nearly impenetrable entanglements.

HYMENOPHYLLACEAE

Hymenophyllum myriocarpum Hook. Atwood 7770, 6 February 1977 (US). Elfin forest epiphyte.

H. polyanthos (Sw.) Sw. Atwood, Marshall & Neill 6708, 6723, 15 December 1973 (MO).

Trichomanes capillaceum L. Atwood 3902, 27 January 1970 (MO). Cloud forest.

T. krausii Hook. & Grev. Atwood 5468b, 9 April 1971 (MO). Elfin forest.

T. pyxidiferum L. Atwood 7769, 6 February 1977 (US). Elfin forest epiphyte.

T. radicans Sw. Atwood 3900, 27 January 1970 (MO); Neill N45, 29 April 1975 (MSC). Common in elfin forest.

T. rigidum Sw. Atwood, Marshall & Neill 6722, 16 January 1972 (MO). Cloud and elfin forests.

LOPHOSORIACEAE

Lophosoria quadripinnata (Gmel.) C. Chr. Atwood A297, 5 June 1975 (MSC). Plan de las Flores.

LYCOPODIACEAE

Lycopodium callitrichifolium Mett. Atwood 7774, 6 February 1977 (US). Very rare epiphyte in elfin forest.

L. dichotomum Jacq. Atwood & Neill AN65, 1 July 1975 (MSC). Epiphyte of lower cloud forest.

L. linifolium L. Atwood 7741, 3 February 1977 (MSC). Occasional epiphyte of elfin forest.

L. taxifolium Sw. Atwood 5454, 9 April 1972 (MO). Epiphyte.

L. verticillatum var. *parvifolium* (Wercklé ex Nessel) Lellinger. Atwood 7740, 3 February 1977 (US). Very rare epiphyte in elfin forest.

MARATTIACEAE

Marattia interposita Christ. Atwood & Neill AN188, 16 July 1975 (MSC). Upper cloud and elfin forest.

OPHIOGLOSSACEAE

Ophioglossum reticulatum L. Atwood A353, 10 July 1975 (MSC). Very abundant at disturbed area of Plan de las Flores.

POLYPODIACEAE

Grammitis blepharodes (Maxon) Seymour. Atwood 5453, 9 April 1971 (MO); Atwood, Marshall & Neill 6728, 16 December 1973 (MO). Upper cloud and elfin forest epiphyte.

G. serrulata (Sw.) Sw. Atwood A25, 29 April 1975 (MSC). Upper cloud and elfin forest.

G. staheliana (Posth.) Lellinger. Atwood 7773, 6 February 1977 (US). Apparently a very rare epiphyte of elfin forest.

Microgramma lycopodioides (L.) Copel. Neill N27, 26 April 1975 (MSC). Common at Plan de las Flores.

Phlebodium aureum (L.) J. Smith. Atwood A163, 15 May 1975 (MSC). Common at Plan de las Flores.

Pleopeltis percussa (Cav.) Hook. & Grev. Atwood & Neill AN63, 1 July 1975 (MSC). Epiphytic in lower cloud forest.

P. revoluta (Sprengel ex Willd.) A. R. Smith (syn. *Polypodium astrolepis* Liebm.). Atwood 7733, 3 February 1977 (US).

Polypodium angustifolium Sw. Atwood 7738, 3 February 1977 (MSC). Very common epiphyte of elfin forest.

P. dissimile L. Atwood 3906, 27 January 1970 (MO); Neill N43, 29 April 1975 (MSC). Lower cloud forest on east flank. About 800 m.

P. cf. fruticosum Maxon & Weath. Robbins 6251, 1 August 1972 (MO). Probably also Seymour 6098, 25 July 1972 (MO). Lower cloud forest.

P. loriceum L. Atwood, Marshall & Neill 6725, 16 December 1973 (MO). Northwest crater rim. Atwood A167, 15 May 1975 (MSC). Plan de las Flores.

P. plebejum Schlecht. & Cham. Atwood 3905, 27 January 1970 (MO). Cloud forest inhabitant.

P. plesiosorum Kunze. Seymour 6097, 25 July 1972 (MO). Lower cloud forest.

P. plumula Humb. & Bonpl. ex Willd. Atwood & Neill AN91, 2 July 1975 (MSC). Growing on boulders in margin of cloud and deciduous forest.

P. polypodioides (L.) Watt var. *polypodioides*. Atwood & Neill AN92, 2 July 1975 (MSC). In margin of deciduous and lower cloud forest.

P. wiesbaueri Sod. Atwood 5452, 9 April 1971 (VT). Upper cloud forest.

SCHIZEACEAE

Lygodium venustum Sw. Seymour 6096, 25 July 1972 (MO); Atwood & Neill AN86, 2 July 1975 (MO). In lower cloud and deciduous forests.

SELAGINELLACEAE

Selaginella sp. Atwood 7730, 3 February 1977 (MSC). Prostrate species common in elfin forest.

THELYPTERIDACEAE

Thelypteris balbisii (Sprengel) Ching. Baker 2449 (GH).

T. columbiana (C. Chr.) Morton. Atwood A26, 29 April 1975 (MSC). Upper cloud and elfin forests.

T. dentata (Forsk.) E. St. John. Atwood AA44, 30 April 1975 (MSC). Upper cloud forest.

T. mombachensis Gomez. Atwood A304a, 5 June 1975 (MSC); Atwood, Marshall & Neill 6726, 16 December 1973 (MO). Elfin forest at Plan de las Flores.

FLOWERING PLANTS

ACANTHACEAE

Aphelandra deppeana Schlecht. & Cham. Dudgey & Moore 1959, 9 January 1969 (MO).

A. aurantiaca (Scheidw.) Lindl. Atwood 77108, 8 February 1977 (FSU, MO, MSC). Locally common in deciduous forest at Finca Las Delicias. Flowers canary yellow.

Blechnum brownei Juss. Atwood A156, 15 May 1975 (MSC). Weed of disturbed elfin forest. This and the following may not be distinct.

B. pyramidatum (Lam.) Urb. Nichols 2005, 9 January 1969 (MO).

Dyschoriste skutchii Leonard. Narvaez 3888, 27 January 1970 (MO).

Ruellia inundata H.B.K. Dudgey & Moore 1960, 9 January 1969 (MO). Lower cloud forest.

AMARANTHACEAE

Achyranthes aspera L. Atwood A55, 30 April 1975 (MSC). In disturbed area by vacation house.

Alternanthera williamsonii Standl. Narvaez 3881, 27 January 1970 (MO).

Chamissoa altissima (Jacq.) H.B.K. Dudgey & Moore 1977, 9 January 1969 (MO). Disturbed cloud forest above Finca Las Delicias.

Cyathula achyranthoides (H.B.K.) Moquin. Dudgey & Moore 1979, 9 January 1969 (MO).

Gomphrena decumbens Jacq. Atwood & Neill AN89, 2 July 1975 (MSC). In pastures and roadsides at Finca Las Delicias.

Iresine celosia L. Dudey & Moore 1977, 9 January 1969 (MO). Lower cloud forest. Locally abundant and often sold in markets for decoration.

ANACARDIACEAE

Mangifera indica L. Atwood 3921, 27 January 1970 (MO). An escape in deciduous forest areas.

APOCYNACEAE

Echites cf. *turrigera* Woodson. Atwood & Neill AN71, 2 July 1975 (MSC). Deciduous forest.

Plumeria rubra L. Not collected but often observed as a conspicuous element of the deciduous forest. This is the national flower of Nicaragua. The Mombacho plants have white flowers.

Rauvolfia littoralis Rusby. Atwood & Neill AN84, 2 July 1975 (MSC). Common herb in deciduous forest area near Finca Las Delicias.

Stemmodenia donnell-smithii (Rose) Woodson. Atwood & Neill AN69, 1 July 1975 (MSC). In deciduous forest.

AQUIFOLIACEAE

Ilex aff. *carpenterae* Standl. Atwood A192, 15 May 1975 (MSC). Collected at Plan de las Flores.

ARACEAE

Anthurium cubense Engl. Atwood & Neill AN82, 2 July 1975 (MSC). Common epiphyte in trees of upper deciduous forest areas around Finca Las Delicias. This species forms large rosettes.

A. scandens (Aubl.) Engl. Atwood A50, 30 April 1975 (MSC); Neill N56, 29 April 1975 (MSC). Lower cloud forest epiphyte common in coffee plantations at Finca Cutirre.

Dieffenbachia aurantiaca Engl. Atwood & Neill AN206, 16 July 1975 (MSC). Upper cloud forest ravine above Finca Las Delicias about 900 m.

D. seguine L. Atwood A212, 18 May 1975 (MSC). Common terrestrial in deep shade at about 600 m.

Monstera acuminata C. Koch. Atwood & Neill AN66, 1 July 1975 (MSC). Common liana flanking tall trees of lower cloud forest.

M. adansonii Schott. Atwood A42, 27 April 1975 (MSC); Atwood A172, 15 May 1975 (MSC); Neill N28, 27 April 1975 (MSC); Atwood A363, 10 July 1975 (MSC). Common liana of cloud forests.

Syngonium podophyllum Schott. Atwood & Neill AN90, 2 July 1975 (MSC). Common in deciduous forest areas.

ARALIACEAE

Oreopanax xalapense (H.B.K.) Dcne. & Planch. Atwood A299, A361, 10 July 1975 (MSC). Frequent in upper cloud and elfin forests.

ARECACEAE

Chamaedorea sp. Atwood A171, 15 May 1975 (MSC). Cloud and elfin forests, mostly in disturbed areas.

Undetermined. Atwood & Neill AN50, 1 July 1975 (MSC). Lower cloud forest near Finca Cutirre.

ARISTOLOCHIACEAE

Aristolochia anguicida Jacq. Atwood & Neill AN81, 2 July 1975 (MSC). In deciduous forest near Finca Las Delicias, growing near the following species. Collection in fruit only.

A. cf. maxima Jacq. Atwood & Neill AN77, 2 July 1975 (MSC). Deciduous forest.

ASCLEPIADACEAE

Asclepias curassavica L. Robbins 6260, 1 August 1972 (MO). Lower cloud and deciduous forests.

Gonolobus sp. Neill 1363, 3 February 1977 (UCA). Vine of cloud forest.

BEGONIACEAE

Begonia filipes Benth. Dudey & Moore 2004, 9 January 1969 (MO). Cloud forest.

B. plebeja Liebm. Dudey & Moore 1985, 9 January 1969 (MO). Lower cloud forest.

BIGNONIACEAE

Arrabidaea mollissima Bur. & K. Schum. Dudey & Moore 1957, 9 January 1969 (MO). Probably collected in deciduous forest.

Cydista diversifolia (H.B.K.) Miers. Atwood & Neill AN207, 16 July 1975 (MSC). In deciduous forests below Finca Las Delicias.

BIXACEAE

Bixa orellana L. Atwood & Neill AN67, 1 July 1975 (MSC). Common in lower cloud forest above Finca Cutirre.

BOMBACACEAE

Ceiba sp. No collection made. Forms immense crowns supporting numerous epiphytes. Throughout deciduous forest.

Quararibea funebris (Llave) Vischer. Neill 1008, 3 October 1976 (FSU). Tree about 25 m tall. Lower cloud forest.

BORAGINACEAE

Cordia dentata Poir. Atwood & Neill AN75, 2 July 1975 (MSC). Finca Las Delicias in deciduous forest.

Heliotropium indicum L. Atwood & Neill AN74, 2 July 1975 (MSC). Deciduous forest near Finca Las Delicias.

BROMELIACEAE

Catopsis sp. Atwood & Neill AN205, 16 July 1975 (MSC). Cloud forest.

Guzmania angustifolia (Baker) Wittm. Neill 7582, 8 August 1976 (MO).

G. compacta Mez. Neill 7583, 8 August 1976 (MO).

G. lingulata var. *minor* (Mez) L. B. Smith. Atwood & Neill AN203, 16 July 1975 (MSC). Common epiphyte of cloud forest. Very attractive species with brilliant red bracts.

G. monostachia (L.) Rusby ex Mez. Atwood & Neill AN204, 16 July 1975 (MSC). Common epiphyte of cloud forests. The contrasting black veined lower bracts and red upper bracts distinguish this from other species of *Guzmania* on Mombacho.

G. nicaraguensis Mez & C. F. Baker. Atwood & Neill AN306, 30 July 1975 (MSC). Uncommon at crater rim. Elfin forest epiphyte.

Pitcairnia heterophylla Beer. Atwood 7796, 8 February 1977 (MSC). Epiphyte of deciduous forest.

P. imbricata (Brongn.) Regel. Neill 7580, 8 August 1976 (UCA). Common in elfin forest at Plan de las Flores.

Tillandsia bulbosa Hook. Atwood & Neill AN58, 1 July 1975 (MSC). Lower cloud forest.

T. fasciculata Sw. Atwood 5459, 9 April 1971 (VT). Cloud and elfin forest epiphyte.

T. festucoides Brongn. ex Mez. Atwood & Neill AN56, 1 July 1975 (MSC). Lower cloud forest.

T. leiboldiana Schlecht. Neill 7529, 7 August 1976 (MO).

T. monadelpha (E. Morr.) Baker. Atwood & Neill AN52, 1 July 1975 (MSC). Lower cloud forest.

T. schiediana Steud. Atwood & Neill AN80, 2 July

1975 (MSC). Most abundant in dry deciduous forest.

T. usneoides L. Atwood 3916, 27 January 1970 (MO). Common cloud forest epiphyte.

Vriesea pedicellata (Mez & Werckle) Sm. & Pitt. Atwood A16, 29 April 1975 (MSC). Elfin forest epiphyte.

V. sp. Atwood A15, 29 April 1975 (MSC). Upper cloud forest.

BURSERACEAE

Bursera simaruba (L.) Sarg. Atwood & Neill AN214, 16 July 1975 (MSC). Common tree of deciduous forest.

CAMPANULACEAE

Lobelia laxiflora H.B.K. Atwood 5477, 9 April 1971 (VT). Elfin forest.

CAPPARACEAE

Forchhammeria matudai Lundell. Atwood 77116, 8 February 1977 (MSC). Lower cloud forest tree.

CAPRIFOLIACEAE

Viburnum hartwegii Benth. Atwood A200, 14 May 1975 (MSC). In disturbed sites of elfin forest at Plan de las Flores.

CARICACEAE

Carica papaya L. Not collected but observed in lower cloud forest in deep shade.

CARYOPHYLLACEAE

Drymaria cordata (L.) Willd. ex Roem & Schult. Neill 1003, 3 October 1976 (UCA). Coffee plantation weed.

CHLORANTHACEAE

Hedyosmum montanum W. Burger. Neill 408, 28 May 1976 (MSC). Common elfin forest tree.

CHRYSOBALANACEAE

Chrysobalanus icaco L. Robbins 6261, 1 August 1972 (MO). Probably lower cloud forest.

COCHLOSPERMACEAE

Cochlospermum vitifolium Willd. Atwood & Neill AN78, 2 July 1975 (MSC). Common deciduous forest component, but found as high as 800 m.

COMBRETACEAE

Combretum fruticosum (Loeff.) Stuntz. Dudgey & Moore 1951, 9 January 1969 (MO). Probably lower cloud forest.

COMMELINACEAE

Campelia hirsuta Standl. Dudgey & Moore 1974a, 9 January 1969 (MO).

C. zanonii (L.) H.B.K. Neill N50, 29 April 1975 (MSC). Common in cloud forest.

Commelina erecta L. Narvaez 3884, 27 January 1970 (MO). Cloud and elfin forest.

Dichorisandra hexandra (Aubl.) Standl. Atwood & Neill AN186, 15 May 1975 (MSC); Neill N49, 29 April 1975 (MSC). Local in cloud forests.

Phaeosphaerion persicariaefolium (DC.) C. B. Clarke. Atwood A168, 15 May 1975 (MSC). On disturbed sites at Plan de las Flores.

Tripogandra cf. cumanensis (Kunth) Woodson. Atwood A44, 30 April 1975 (MSC). In disturbed sites at Plan de las Flores.

COMPOSITAE

Baccharis trinervis (Lam.) Pers. Atwood A7, 29 April 1975 (MSC); Atwood A43, 30 April 1975 (MSC). Disturbed areas near vacation house.

Bidens pilosa L. Reported by F. C. Seymour (pers. comm.).

B. riparia H.B.K. Narvaez 3891, 27 January 1970 (MO).

B. squarrosa H.B.K. Atwood 3924, 27 January 1970 (MO).

Chaptalia nutans (L.) Hemsl. Seymour 6105, 25 July 1972 (VT). Common in disturbed areas of cloud forest.

Chromolaena odorata (L.) King & Robinson. Atwood A54, 29 April 1975 (MO). Disturbed site at vacation house.

Cirsium mexicanum DC. Atwood 5479, 9 April 1971 (MO); Atwood A46, 30 April 1975 (MSC); Neill N60, 30 April 1975 (MSC). Disturbed cloud forest.

Clibadium leiocarpum Steetz. Atwood A161, 15 May 1975 (MSC). Small tree in elfin forest.

Conyza chilensis Sprengel. Atwood A183, 15 May 1975 (MSC). Disturbed site at Plan de las Flores.

Delileia biflora (L.) Kuntze. Atwood 3923, 27 January 1970 (MO). Disturbed cloud forest.

Erectites hieracifolia (L.) R. Nichols 2014, 9 January 1969 (MO). Disturbed cloud forest.

Erigeron bonariensis L. Narvaez 3895, 27 January 1970 (MO). Disturbed area in cloud forest above Finca Las Delicias.

Eupatorium araliaefolium Less. Atwood 77142, 20 September 1977 (MSC). Small tree of disturbed cloud forest on northeast flank.

E. sinclairii (Benth.) King & Robinson. Narvaez 3894, 27 January 1970 (MO). In disturbed area of cloud forest at vacation house.

Fleischmannia pratensis (Klatt) King & Robinson. Atwood A155, 15 May 1975 (MO). Disturbed site at Plan de las Flores.

Galinsoga cf. ciliata (Raf.) Blake. Narvaez 3893, 27 January 1970 (MO). Disturbed cloud forest.

Hebeclinium macrophyllum (L.) DC. Neill 775, 19 September 1976 (MSC). Deciduous forest weed.

Liabum cf. discolor (Hook. & Arn.) Benth. & Hook. ex Hemsl. Atwood A188a, 15 May 1975 (MSC). Rare in disturbed elfin forest.

Melampodium divaricatum (L. Rich. ex Pers.) DC. Atwood & Neill AN85, 2 July 1975 (MSC). Deciduous forest.

Melanthera nivea (L.) Small. Dudgey & Moore 1961, 9 January 1969 (MO). Cloud forest.

Neurolaena lobata R. Br. Atwood 77107, 8 February 1978 (MSC). Weed of disturbed cloud forest.

Perymenium nicaraguense Blake. Dudgey & Moore 1991, 9 January 1969 (MO).

Pseudelephantopus spicatus (Juss.) C. F. Baker. Nichols 2011, 9 January 1969 (MO). Weed of disturbed cloud forest.

Senecio arborescens Steetz in Seem. Neill N38, 30 April 1975 (MSC); Atwood A21, 29 April 1975 (MSC). Common tree in upper cloud forest.

Spilanthes americana (L. f.) Hieron. ex Sodi. Atwood A19, 29 April 1975 (MSC); Atwood A175, 15 May 1975 (MSC). On crater rim and at vacation house.

S. ocymifolia (Lam.) A. H. Moore. Narvaez 3892, 27 January 1970 (MO).

Verbesina fraseri Hemsl. Dudgey & Moore 1963, 9 January 1969 (MO).

Vernonia canescens H.B.K. Atwood A181, 15 May 1975 (MO). Common in disturbed elfin forest.

V. patens H.B.K. Atwood & Neill 1567, 14 March

1977 (FSU). Lower cloud forest weed at Finca Cutirre.

CONVOLVULACEAE

Ipomoea alba L. Atwood 77112, 8 February 1970 (MSC). Roadside vine at Finca Cutirre.

Merremia tuberosa (L.) Rendle. Neill 1565, 14 March 1977 (MSC). Collected by a local resident for decoration.

M. umbellata (L.) Hallier f. Atwood 77146, 10 February 1977 (MSC). Locally common lower cloud forest vine.

Quamoclit hederifolia (L.) G. Don. Dudgey & Moore 1956, 9 January 1969 (MO); Atwood 77145, 10 February 1977 (MSC).

COSTACEAE

Costus cf. *sanguineus* Donn.-Sm. Nichols 1998, 9 January 1969 (MO).

CRUCIFERAE

Rorippa indica (L.) Hieron. Narvaez 3886, 27 January 1970 (MO). In disturbed cloud forest.

CUCURBITACEAE

Melothria pendula L. Atwood A180, 15 May 1975 (MSC). Common vine of disturbed cloud forest.

Momordica charantia L. Atwood 77117, 8 February 1977 (MSC). Weed of coffee plantations.

Rytidostylis ciliata (Oerst.) Monachino. Atwood & Neill AN304, 30 July 1975 (MSC). Disturbed forest areas.

CYPERACEAE

Carex cf. *donnell-smithii* L. H. Bailey. Atwood A162, 15 May 1975 (MSC). Common herb of elfin and cloud forests. Spikes seem a bit short for the above species.

C. polystachya Sw. ex Wahl. Atwood, Marshall & Neill 6733, 16 January 1973 (MO); Atwood A197, 14 May 1975 (MSC). Not uncommon in elfin forest.

Cyperus mutisii (H.B.K.) Griseb. Robbins 6256, 1 August 1972 (MO).

C. tenuis Sw. Dudgey & Moore 1973, 9 January 1969 (MO). Common in disturbed areas at low and high elevations.

C. sp. Atwood A182, 15 May 1975 (MSC). In open areas at Plan de las Flores.

Rhynchospora polyphylla Vahl. Atwood A179, 15 May 1975 (MSC). Common in disturbed areas of elfin forest.

Uncinia hamata (Sw.) Urban. Atwood 5457, 9 April 1971 (MO). Common in elfin and cloud forests.

ELAEOCARPACEAE

Muntingia calabura L. Seymour 6103, 25 July 1972 (MO). Common tree of deciduous forest area.

ERICACEAE

Cavendishia crassifolia (Benth.) Hemsl. Atwood A35, 30 April 1975 (MSC); Neill N24, 26 April 1975 (MSC). Abundant in upper cloud and elfin forests.

Satyria warszewiczii Klotzsch. Neill 1101, 25 October 1976 (FSU). Elfin forest tree.

Sphrospermum majus Griseb. Atwood A11, 29 April 1975 (MSC). Common epiphyte of upper cloud and elfin forests.

EUPHORBIACEAE

Acalypha diversifolia Jacq. complex. Atwood 7744, 3 February 1977. Locally common tree of elfin forest.

A. setosa A. Rich. Atwood & Neill AN48, 1 July 1975 (MSC). Common weed of coffee plantation.

Croton cf. *pungens* Jacq. Neill 1407, 8 February 1977 (MSC). Tree of deciduous forest below Finca Las Delicias.

Euphorbia cf. *graminea* Jacq. Narvaez 3883, 27 January 1970 (MO). Common in disturbed cloud forest area.

Ricinus communis L. Dudgey & Moore 1952, 9 January 1969 (MO). Below upper cloud forest level.

Sapium macrocarpum Muell. Arg. Atwood 77147 (MSC). Common tree of cloud forest.

FLACOURTIACEAE

Casearia corymbosa Jacq. Atwood & Neill AN213, 16 July 1975 (MSC). Common shrub in deciduous forest near Finca Las Delicias.

GESNERIACEAE

Achimenes misera Lindl. Atwood, Marshall & Neill 6736, 16 December 1973. Apparently rare terrestrial on crater rim.

Columnnea rubricaulis Standl. ex Yuncker. Atwood 5476, 9 April 1971 (MO). Common epiphyte of cloud and elfin forests.

Kohleria spicata (H.B.K.) Oersted. Atwood 7737, 3 February 1977 (MSC). Common terrestrial herb on disturbed embankments of access road on north flank.

GRAMINEAE

Arundinella deppeana Nees. Atwood A40, 30 April 1975 (MO). Common in disturbed areas at Plan de las Flores.

Eleusine indica (L.) Gaertner. Dudgey & Moore 1970, 9 January 1969 (MO). Common herb of lower cloud forest.

Isachne arundinacea (Sw.) Griseb. Atwood A10, 29 April 1975 (MO, MSC). Vine forming impenetrable mats in elfin forest.

Lasiacis ruscifolia (H.B.K.) Hitchc. Dudgey & Moore 1948, 9 January 1969 (MO). Common in disturbed areas of cloud forests.

Oplismenus burmannii (Retz.) Beauv. Dudgey & Moore 1972, 9 January 1969 (VT); Atwood A158, 15 May 1975 (MSC). Locally common in upper cloud and elfin forests.

O. hirtellus (L.) Beauv. Atwood A10a, 29 April 1975 (MSC). Common in elfin forest.

Panicum sphaerocarpon Ell. Neill 868, 26 September 1976 (UCA).

P. trichoides Sw. Dudgey & Moore 1971, 9 January 1969 (VT). Probably from lower cloud forest or deciduous forest.

Paspalum conjugatum Berg. Robbins 6255a, 1 August 1972 (MO).

P. paniculatum L. Seymour 7521, 6 August 1976 (MO). Frequently the dominant grass in upper cloud and elfin forests.

Setaria paniculifera (Steudel) Fourn. Atwood A360, 10 July 1975 (MSC). Common in disturbed elfin forest with *Arundinella* and *Epidendrum radicans*.

Sporobolus indicus (L.) R. Br. Atwood A199, 14 May 1975 (MO). Common in disturbed elfin forest.

GUTTIFERAE

Clusia salvinii Donn.-Sm. Atwood A311, 5 June 1975 (MSC); Neill N222, 7 June 1975 (MSC). Very common especially in forest where nearly solid stands are to be found along the most windswept ridges.

HAEMODORACEAE

Xiphidium caeruleum Aubl. Neill 2922. Common herb of disturbed embankments.

HELICONIACEAE

Heliconia cf. *collinsiana* Griggs. Observed near Finca Cutirre. Banana sized plant with pendulous inflorescences.

H. latispatha Benth. Williams & Molina 200027 (F).

LABIATAE

Hyptis cf. *mociniana* Benth. Atwood A185, 15 May 1975 (MSC). Weed in open disturbed area of elfin forest.

H. verticillata Jacq. Nelson 7596, 8 August 1976 (MO).

Salvia occidentalis Sw. Nichols 2006, 9 January 1969 (MO). In disturbed areas of cloud forest.

LAURACEAE

Ocotea veraguensis (Meisn.) Mez. Baker 2493, 20 February 1903 (MSC). "Small tree, 20–30 ft. high Flowers with strong and pleasant odor Occasional in high forests" (from Baker herbarium sheet).

LEGUMINOSAE

Cassia grandis L. f. Neill 1561, 14 March 1977. Deciduous forest.

C. spectabilis DC. Neill 2723, 12 October 1977 (MO, UCA).

Desmodium affine Schlecht. Nichols 2001, 9 January 1969 (VT).

D. aff. *costaricense* (Schindl.) Standl. Atwood 7734, 3 February 1977 (MSC). Occasional in disturbed areas of elfin forest.

D. cf. *incanum* DC. Neill N227, 6 June 1975 (MSC). Cloud forest.

D. sp. Neill 1005, 30 October 1976 (MSC). Lower cloud forest.

Gliricidia sepium (Jacq.) Steud. Neill 1565, 14 March 1977 (MSC). Tree cultivated for shade in coffee plantation.

Inga sapindoides Willd. Neill 1406, 8 February 1977 (FSU). Deciduous forest tree, perhaps planted.

Mimosa pudica L. Not collected. Common in open disturbed areas of cloud forest.

Mucuna argyrophylla Standl. Neill 777, 19 September 1976 (MSC). Cloud forest vine.

Schizolobium parahybum (Vell.) Blake. Neill s.n. (MSC). Tree of lower cloud and deciduous forest.

LENTIBULARIACEAE

Utricularia cf. *praetermissa* P. Taylor. Possibly a new species. Atwood A351, 10 July 1975 (MSC); Atwood & Neill AN307, 30 July 1975 (MSC). Locally abundant epiphyte in cloud and elfin forest.

LILIACEAE

Hippeastrum cf. *solandriiflorum* Herb. Atwood A364, 10 July 1975 (MSC). Probably once cultivated. Plan de las Flores.

Hypoxis decumbens L. Neill N226, 5 June 1975 (MSC). Disturbed areas of cloud forest. Probably common.

MALPIGHIACEAE

Byrsonima crassifolia (L.) H.B.K. Neill 2640. Small tree of deciduous forest.

MALVACEAE

Hibiscus rosa-sinensis L. Atwood A191, 15 May 1975 (MSC). Once cultivated at Plan de las Flores but now abandoned.

Pavonia rosea Schlecht. Neill 875, 26 September 1976 (FSU).

Sida acuta Burm. Robbins 6273, 1 August 1972 (MO). Common weed of deciduous forest.

MARANTACEAE

Calathea macrosepala var. *macrosepala* K. Schum. Atwood & Neill AN192, 16 July 1975 (MSC). Common in forest edges of lower cloud forest.

Maranta arundinacea L. Atwood A357, 10 July 1975 (MSC). Common in coffee plantations on north flank, but probably more widespread in lower cloud forest.

MARCGRAVIACEAE

Marcgravia brownei (Tr. & Planch.) Krug & Urban. Atwood A22, 29 April 1975 (MSC); Neill N223, 7 June 1975 (MSC). Common vine of elfin forest.

MELASTOMATACEAE

Arthrostemma ciliata R. & P. Atwood A188, 15 May 1975 (MSC). Uncommon vine of disturbed elfin forest.

Centradenia cf. *inaequilateralis* (Schlecht. & Cham.) G. Don. Narvaez 3926, 27 January 1970 (MO). Disturbed area of cloud forest above Finca Las Delicias.

Clidemia or *Henriettea*? Perhaps a new species. Atwood A350, 10 July 1975 (MSC). Common understory shrub of elfin forest. Very distinctive for its dense bristles distributed throughout the plant.

Conostegia oerstediana Berg ex Triana. Neill N34, 29 April 1975 (MSC); Atwood A174, 15 May 1975 (MSC). Small tree occasional at vacation house and Plan de las Flores.

C. subcrustulata (Beurl.) Triana. Atwood & Neill AN209, 16 July 1975 (MSC). In deciduous forest area below Finca Las Delicias.

Miconia laevigata (L.) DC. Atwood & Neill AN53, 1 July 1975 (MSC). Near Finca Cutirre in lower cloud forest.

M. minutiflora DC. Atwood 3922, 27 January 1970 (VT).

M. cf. *theazans* (Bonpl.) Cogn. Neill N35, 29 April 1975 (MSC). Above Finca Las Delicias in disturbed areas of cloud forest.

Monochaetum deppeanum (Schlecht. & Cham.) Naud. Atwood A173, 15 May 1975 (MSC). Common in open areas of elfin forest. This species ranges north to Mexico and southward to the island of Omotepe in Lake Nicaragua.

Ossaea micrantha (Sw.) Macf. Neill 783, 19 September 1976 (MSC). Cloud forest.

Tibouchina longifolia (Vahl.) Baill. Atwood 7767, 6 February 1977 (FSU). Common in disturbed elfin forest.

MELIACEAE

Trichilia glabra L. Atwood 7745, 8 February 1977 (MSC). Common at smaller crater rims at Plan de las Flores and deciduous forest.

MENISPERMACEAE

Cissampelos pareira L. Neill 998, 3 October 1976 (MSC). Deciduous forest vine.

MOLLUGINACEAE

Mollugo verticillata L. Atwood & Neill AN88, 2 July 1975 (MSC). Weed in open areas at Finca Las Delicias.

MORACEAE

Cecropia peltata L. Atwood & Neill AN70, 1 July

1975 (MSC). Common tree nearly everywhere in disturbed areas.

Ficus sp. Observed in lower cloud forest.

MUSACEAE

Musa paradisiaca L. Not collected but observed at Plan de las Flores. Undoubtedly planted.

MYRSINACEAE

Ardisia minor Standl. Atwood 5475, 9 April 1971 (MO). Elfin forest.

A. nigropunctata Oerst. Neill 1331, 21 November 1976 (FSU).

A. oblanceolata Standl. Atwood 7749, 3 February 1977 (MSC).

A. revoluta H.B.K. Neill 1402, 8 February 1977 (FSU). Lower cloud forest.

Rapanea cf. *ferruginea* Mez. Atwood A159, 15 May 1975 (MSC). Common elfin forest component.

MYRTACEAE

Eugenia oerstedeana Berg. Neill 1403, 8 February 1977 (UCA).

Myrcianthes fragrans (Sw.) McVaugh. Neill N225, 7 June 1975 (MSC). Common in elfin forest.

Psidium × *hypoglaucum* Standl. Atwood A160, 15 May 1975 (MSC). In disturbed area of elfin forest and probably cultivated.

Syzygium jambos (L.) Alston. Neill N21, 26 April 1975 (MSC); Atwood A443, 30 April 1975 (MSC). Near Finca Las Delicias. Probably cultivated.

NYCTAGINACEAE

Cryptocarpus globosus H.B.K. Dudgey & Moore 1978, 9 January 1969 (MO).

Mirabilis jalapa L. Robbins 6528, 1 August 1972 (MO); Atwood A358, 10 July 1975 (MSC). In shaded areas about coffee plantations.

M. violacea Heimerl. Atwood & Neill AN87, 2 July 1975 (MSC). In deciduous forests at Finca Las Delicias.

ORCHIDACEAE

Bletia florida (Salisb.) R. Br. Atwood 77300, March 1977 (Live collection). Occurs with *B. purpurea*, but no intermediates were observed.

B. purpurea (Lam.) DC. Atwood 77160, 15 February 1977 (SEL). Common in open dry areas at Plan de las Flores.

Brassavola nodosa (L.) Lindl. Not collected but not uncommon in deciduous forest.

Catasetum maculatum L. C. Rich. Atwood A32, 30 April 1975 (MSC). In dry deciduous forests.

Caularthron bilamellatum (Rchb. f.) Schultes. Neill 1566, 14 March 1977 (SEL). Cleistogamous population in deciduous forests.

Clowesia russelliana (Hook.) Dodson. Atwood 77135a, 10 February 1977 (Live collection made, SEL). Uncommon in deciduous forests.

Cyrtopodium sp. Occasional epiphyte in deciduous forests below Finca Las Delicias. Living collection presently being grown for determination.

Dichaea graminoides (Sw.) Lindl. Atwood A296, 5 June 1975 (MSC). Occasional in elfin forest.

D. cf. muricata (Sw.) Lindl. Atwood A28, 29 April 1975 (MSC). Upper cloud and elfin forest.

D. aff. rendlei Gleason. Atwood A347, 10 July 1975 (MSC). Very similar to *D. panamensis*, but ovary is muricate. Elfin forest.

D. cf. tuerckheimii Schltr. Atwood A207, 14 May

1975 (MSC). Collection is sterile, but the small size suggests this species. Elfin forest.

Elleanthus cf. *aurantiacus* Rchb. f. Neill N42, 29 April 1975 (MSC); Atwood A184, 15 May 1975 (MSC). Very common epiphyte of elfin forest.

E. cynarocephalus (Rchb. f.) Rchb. f. Atwood A301, 5 June 1975 (MSC); Atwood, Marshall & Neill 6742, 17 December 1973 (MO). Abundant epiphyte in elfin forest.

E. graminifolius (Barb. Rodr.) Løjtnant. Atwood, Marshall & Neill 6743, 17 December 1973 (MO); Atwood A165, 15 May 1975 (MSC). Common in elfin forest.

E. hymenophorus Rchb. f. Neill N32, 30 April 1975 (MSC); Atwood A186, 15 May 1975 (MSC). Common in upper cloud and elfin forest.

Encyclia chacaoensis (Rchb. f.) Dressl. & Pollard. Atwood A2, 27 April 1975 (MSC). Common in lower cloud and deciduous forests.

E. cochleata (L.) Dressl. Neill 1002, 3 October 1976. Common epiphyte in lower cloud and deciduous forests.

E. fragrans (Sw.) Dressl. Atwood A3, 27 April 1975 (MSC). In deciduous and lower cloud forests, but to be expected in elfin forest.

E. gravida (Lindl.) Schltr. Atwood A1, 27 April 1975 (MSC). Uncommon in deciduous forest on south-east flank.

E. vespa (Vell.) Dressl. Atwood 7756, 3 February 1977 (SEL). Uncommon in elfin forest.

Epidendrum difforme Jacq. Atwood 77128, 10 February 1977 (MSC). Cloud forest.

E. lacustre Lindl. Atwood, Marshall & Neill 6738, 16 December 1973 (MO). Scattered throughout the elfin forest.

E. laucheum Rolfe. Atwood 5470, 9 April 1971 (MO). Elfin forest inhabitant.

E. pansamalae Schltr. Neill 885, 26 September 1977 (SEL).

E. physodes Rchb. f. According to files of the late A. H. Heller (now at SEL) this occurs on Mombacho.

E. polyanthus Lindl. Atwood g-62. Collected May 1975.

E. pseudoramosum Schltr. Atwood & Neill 7058, 20 January 1974 (MO). Common in elfin forest.

E. radicans Pavon. Atwood A164, 15 May 1975 (MSC). Common in grassy areas of Plan de las Flores. A few yellow forms were observed, but most are red with a yellow labellum.

E. ramosum Jacq. Atwood, Marshall & Neill 6744, 17 December 1973 (MO). Common in elfin forest.

E. selaginella Schltr. Atwood A206, 14 May 1975 (MSC). Rather common locally at Plan de las Flores.

E. turialvae Rchb. f. Neill 7589, 8 August 1976 (SEL). Rare in cloud forest.

Goodyera bradeorum Schltr. Atwood, Neill & Marshall 6741, 16 December 1973 (MO). Local terrestrial of upper cloud and elfin forests.

Hexadesmia lindeniana R. & C. Atwood 5462, 9 April 1971 (MSC). Occasional in lower cloud forest.

H. micrantha (Lindl.) Ames & Correll. Atwood A4, 27 April 1975 (MSC). Common in lowland deciduous forests.

Isochilus cf. *major* Schlecht. & Cham. Atwood &

- Neill* 7045, 15 January 1974 (MO). Common in cloud forests.
- Jacquinella globosa* (Jacq.) Schltr. *Atwood* 77166, 15 February 1977 (SEL). Occasional inside drier crater rim.
- J. teretifolia* (Sw.) Britt. & Wils. *Atwood* 5460, 9 April 1971 (MO). Common epiphyte on lower flanks of mountain in deciduous forests, but found also in protected areas of elfin forest.
- Kegeliella* sp. *Atwood* A211, 8 May 1975 (SEL). Rare in elfin forest (plant sterile).
- Lepanthes* sp. No. 1. *Atwood* 77161, 15 February 1977 (SEL). Local in elfin forest. Close to *L. turialvae*, but lip lacks midlobe.
- L.* sp. No. 2. *Atwood* 77143, 10 February 1977 (SEL). Upper cloud forest. Leaves are orbicular, as with species No. 3, but petals are differently shaped.
- L.* sp. No. 3. *Atwood* 77165, 15 February 1975 (SEL). Cloud forest.
- Lockhartia hercodonta* Rchb. f. ex Krzl. *Atwood* 5468, 9 April 1971 (MO). Locally common in cloud forests.
- Lycaste aromatica* Lindl. Live collection made (SEL). Local in cloud forest on north flank.
- L. macrophylla* (Poepp. & Endl.) Lindl. *Atwood* g-65, 16 December 1973 (SEL). Upper cloud forest. Uncommon.
- Malaxis maxonii* Ames. *Atwood* A6, 29 April 1975 (MSC). Common in cloud and elfin forests where it sometimes is encountered as an epiphyte. Mombacho is the type locality of the species.
- M. tipuloides* (Lindl.) Kuntze. *Atwood* A345, 10 July 1975 (MSC). Upper cloud forest inhabitant. This may be the northernmost limit of the species.
- Masdevallia chontalensis* Rchb. f. *Atwood* & Neill AN305, 30 July 1975 (MSC). Common in cloud and elfin forests.
- M. simula* Rchb. f. *Atwood* & Neill 7042, 15 January 1974 (MO). Apparently rare in upper cloud and elfin forests.
- Maxillaria brunnea* Linden & Rchb. f. *Atwood* 7781, 5 February 1977 (SEL). Uncommon in cloud forest.
- M. crassifolia* (Lindl.) Rchb. f. *Atwood* 7798, 8 February 1977 (SEL). Epiphyte of lower cloud forest.
- M. mombachoensis* Heller ex *Atwood*. *Atwood* 7757, 3 February 1977 (SEL). Common epiphyte in elfin forest. Apparently endemic to Volcán Mombacho.
- M. neglecta* (Schltr.) L. O. Wms. *Atwood* 7782a, 5 February 1977 (SEL).
- M. aff. reichenheimiana* Rchb. f. *Atwood* 77159, 15 February 1977 (SEL).
- M. tenuifolia* Lindl. *Atwood* & Neill AN59, 1 July 1975 (MSC). Lower cloud forests.
- M. uncata* Lindl. *Atwood* & Neill 7038, 15 January 1974 (MO). Localized in areas of cloud forests.
- M. variabilis* Batem. ex Lindl. Plants observed in cloud forest in December 1973.
- Mesospinidium warszewiczii* Rchb. f. *Atwood* 7778, 5 February 1977 (SEL). Uncommon epiphyte in shade of upper cloud forest.
- Mormodes* sp. No collection made. Rare in deciduous forest, living on rotting branches.
- Nidema boothii* Schltr. Uncollected, but occasional epiphyte of lower cloud forest.
- Oncidium ascendens* Lindl. *Atwood* 3917, 27 January 1970 (MO). In deciduous forest around Finca Las Delicias.
- O. stenotis* Rchb. f. *Atwood* 77101, 8 February 1977. Uncommon in lower cloud forest.
- Platystele compacta* Ames. *Atwood* & Neill 7043, 15 January 1974 (MSC). Not uncommon in cloud forest.
- Pleurothallis blaisdelii* S. Wats. *Atwood* & Neill 7040, 15 January 1974 (MO). Uncommon in upper cloud and elfin forest.
- P. convallaria* Schltr. *Atwood*, Marshall & Neill 6745, 17 December 1973 (MO). Flowers white and dark red-purple. Found only in elfin forest on northwest flank.
- P. cf. erinacea* Rchb. f. *Atwood* & Neill 7063, 20 January 1974 (SEL). Rare epiphyte in cloud forest.
- P. foliata* Griseb. *Atwood* A12, 29 April 1975 (MSC); *Atwood* A300, 5 June 1975 (MSC). Locally abundant, but an inconspicuous epiphyte of cloud and elfin forests.
- P. guanacastensis* Ames & Schweinf. *Atwood* & Neill 7044, 15 January 1974 (SEL). In elfin forest. This is an apparent range extension from Costa Rica.
- P. pruinosa* Lindl. *Atwood* 77100, 8 February 1977 (FSU). Lower cloud forest on trees above Finca Cutirre.
- P. racemiflora* Lindl. ex Hook. *Atwood* g-63 (MSC). Common in lower cloud forest where it often forms great masses. Also in deciduous forest.
- P. ruscifolia* (Jacq.) R. Br. *Atwood* 77126, 10 February 1977 (SEL).
- P. sertularioides* (Sw.) Sprengel. *Atwood* & Neill AN54, 1 July 1975 (MSC). Collection made north of Finca Cutirre at about 550 m.
- P. tribuloides* (Sw.) Lindl. *Atwood*, Marshall & Neill 7046, 15 January 1974 (MO). Local cloud forest inhabitant. This species is distinctive for its bright red flowers and echinate ovaries.
- Polystachya masayensis* Rchb. f. *Atwood* & Neill AN60, 1 July 1975 (MSC). In deciduous forests at Finca Cutirre.
- Ponera* cf. *striata* Lindl. *Atwood* 5463, 9 April 1971 (MO). Upper cloud forest.
- Prescottia stachyodes* (Sw.) Lindl. *Atwood* 77155, 15 February 1977 (SEL). Uncommon in elfin forest.
- Psilochilus* cf. *macrophyllus* (Lindl.) Ames. *Atwood* & Neill AN308, 30 July 1975 (MSC). Rare along crater rim above vacation house.
- Scaphyglottis behrii* (Rchb. f.) Benth. & Hook. ex Hemsl. *Atwood* 7794, 8 February 1977 (MSC, SEL). Local in lower cloud forest.
- Sobralia hawkesii* A. H. Heller. *Atwood* & Neill 7059, 20 January 1974 (MO). Common epiphyte of trees and nearly vertical cliffs.
- Spiranthes acaulis* (J. E. Sm.) Cogn. *Atwood* 77115, 8 February 1977 (MSC, SEL). In lower cloud forest of Finca Cutirre.
- S. elata* (Sw.) L. C. Rich. *Atwood* 77148, 10 February 1977 (SEL). Rare in cloud forest. Only collected once.
- Stanhopea wardii* Lodd. ex Lindl. *Atwood* 77122, 20 September 1977 (MSC). Uncommon in cloud forest.
- Stelis cucullata* Ames. *Atwood* A194, 14 May 1975

(MSC). Common in upper cloud and elfin forests. Other species of *Stelis* undoubtedly occur on Mombacho.

Trevoria glumacea Garay ? Atwood A209, 18 May 1975 (MSC). One budded plant found on south-east flank near top of highest peak. Known from Costa Rica and Omotepe.

Trichopilia sp. Observed in cloud forest, but not flowering or fruiting.

Trigonidium egertonianum Batem. Atwood & Neill AN61, 1 July 1975 (MSC). Common epiphyte in upper deciduous and lower cloud forests. The above collection is sterile, but undoubtedly represents this species.

Tropidia polystachya (Sw.) Ames. Atwood & Neill 7041, 15 January 1974 (MO). Cloud forest on southeast slope. Uncommon terrestrial.

Xylobium elongatum (Lindl.) Hemsl. Atwood & Neill 7061, 20 January 1974 (MO). Not uncommon in upper cloud forest.

OXALIDACEAE

Oxalis neaei DC. Atwood A34, 30 April 1975 (MSC).

Weed of disturbed area around vacation house. This may be the same as the following.

O. yucateensis Kunth. Nichols 2002, 9 January 1969 (VT).

PAPAVERACEAE

Bocconia arborea S. Watson. Atwood 7743, 3 February 1977 (MSC). Upper cloud forest tree.

PASSIFLORACEAE

Passiflora biflora Lam. Atwood A33, 30 April 1975 (MSC). In disturbed area at vacation house.

P. edulis Sims. Neill 7506, 6 August 1976 (MO). Probably escaped.

P. sexiflora Juss. Neill 1095, 25 October 1976 (FSU).

PEDALIACEAE

Sesamum indicum L. Atwood & Neill AN208, 16 July 1975 (MSC). Deciduous forest escape.

PHYTOLACCACEAE

Petiveria alliacea L. Dudgey & Moore 1980, 9 January 1969 (MO). Disturbed areas of cloud forest.

Phytolacca rivinoides Kunth & Bouché. Neill N48, 29 April 1975 (MSC). Weed in disturbed area of vacation house.

Rivina humilis L. Dudgey & Moore 1981, 9 January 1969 (MO). Cloud forest.

PIPERACEAE

Peperomia cyclophylla Miq. Atwood & Neill AN94, 2 July 1975 (MSC). Epiphyte of lower cloud forest on margin with deciduous forest.

P. deppeana Schlecht. & Cham. Nichols 2207, 9 January 1969 (MO).

P. hylophila C. DC. Neill N26, April 1975 (MSC); Neill N52, 30 April 1975 (MSC). Rather common in cloud forests.

P. cf. obtusifolia (L.) A. Dietrich. Atwood 7746, 3 February 1977 (MSC). Epiphyte of elfin and cloud forest.

P. serpens (Sw.) Loud. Neill N36, 29 April 1975 (MSC). Cloud forest epiphyte.

Piper aduncum L. Neill N22, 26 April 1975 (MSC). Upper deciduous or lower cloud forest on south-east flank.

P. amalago L. Atwood A312, 5 June 1975 (MSC). Small tree at Plan de las Flores.

P. auritum H.B.K. Atwood & Neill AN301, 30 July 1975 (MSC). In ravine of lower cloud forest above Finca Las Delicias.

P. pseudofuliginum C. DC. Atwood A41, 30 April 1975 (MSC); Atwood & Neill AN211, 16 July 1975 (MSC). Disturbed areas of lower cloud forest.

P. cf. umbricola C. DC. Atwood A8, 29 April 1975 (MSC); Neill N33, 29 April 1975 (MSC). Disturbed area of cloud forest above 900 m.

Pothomorphe umbellata (L.) Miq. Atwood & Neill AN49, 1 July 1975 (MSC). Weedy and common in disturbed areas of cloud forest.

PLUMBAGINACEAE

Plumbago scandens L. Atwood & Neill AN83, 2 July 1975 (MSC). Common deciduous forest herb.

POLYGALACEAE

Monnina xalapensis H.B.K. Atwood 5472, 9 April 1971 (MO); Atwood A352, 10 July 1975 (MSC). In disturbed areas at Plan de las Flores.

POLYGONACEAE

Coccoloba uvifera (L.) Jacq. Atwood A45, 1 July 1975 (MSC). Cultivated plant at vacation house.

PORTULACAEAE

Talinum cf. paniculatum (Jacq.) Gaertn. Not collected, but observed in deciduous forest areas.

RHAMNACEAE

Karwinskia cf. humboldtiana (R. & S.) Zucc. Atwood & Neill AN212, 16 July 1975 (MSC). Common shrub in deciduous forest below Finca Las Delicias.

ROSACEAE

Rubus aff. *hadrocarpus* Standl. & Steyererm. Atwood A9, 29 April 1975 (MSC); Atwood A36, 30 April 1975 (MSC). Common shrub of disturbed areas of crater rim, elfin forest, and cloud forest. The determination is questionable because of the glabrous drupelets.

RUBIACEAE

Borreria laevis (Lam.) Griseb. Robbins 6266, 1 August 1972 (MO). Common weed of disturbed area of vacation house.

Coccosypselum hirsutum Bartling ex DC. Atwood A256, 10 July 1975 (MSC). Elfin forest component at Plan de las Flores.

Coffea arabica L. Robbins 6267, 1 August 1972 (MO). Introduced and cultivated, but expected to escape. *Guettarda crispifolia* Vahl. Neill 407, 28 May 1976 (UCA).

Hamelia patens Jacq. Atwood A53, 30 April 1975 (MSC). Common and perhaps dominant shrub of disturbed area above Finca Las Delicias.

H. rovirosae Wernh. Robbins 6268, 1 August 1972 (MO).

Hemidiodia ocymifolia (Willd.) K. Schum. Seymour 7516, 6 August 1976 (MO).

Hoffmannia oreophila L. O. Wms. Neill N53, 29 April 1975 (MSC). Upper cloud forest.

Manettia reclinata L. Neill 1102, 25 October 1976 (MSC). Elfin forest.

Palicourea angustifolia H.B.K. Hall & Bockus 7541, 7 August 1976 (MO). Cloud forest.

P. galeottiana Mart. Atwood A346, 10 July 1975 (MSC). Small tree at Plan de las Flores. Rather common. Other species of *Palicourea* undoubtedly occur on Mombacho.

Psychotria graciflora Benth. ex Oerst. Atwood A293, 5 June 1975 (MSC). Elfin forest component at Plan de las Flores.

P. cf. minarum St. & St. Atwood, Marshall & Neill 6735, 16 December 1973 (MO). Shrub in shade of upper cloud forest.

P. molinae Standl. Hall & Bockus 7542, 7 August 1976. Cloud forest.

P. oerstediana Standl. Hall & Bockus 7572, 8 August 1976 (MO). Upper cloud forest.

P. aff. trichotoma Mart. & Gal. Atwood A57, 29 April 1975 (MSC); Atwood A212b, 18 May 1975 (MSC). Shrub or small tree of cloud forest.

P. uliginosa Sw. Atwood A23, 29 April 1975 (MSC); Atwood A291, 5 June 1975 (MSC); Atwood & Neill AN189, 16 July 1975 (MSC). Upper cloud and elfin forest. Purple flowered shrub of elfin forest.

P. sp. Atwood & Neill AN216, 16 July 1975 (MSC). Roadside in deciduous forest area below Finca Las Delicias.

Richardia scabra L. Seymour 7517, 6 August 1976 (MO). Deciduous forest weed.

SAPINDACEAE

Paullinia clavifera Schlecht. Atwood & Neill AN210, 16 July 1975 (MSC). Deciduous forest inhabitant.

Serjania sp. Neill 1401, 6 February 1977 (FSU). Deciduous forest vine.

SAPOTACEAE

Manilkara sp. Neill 1563a, 8 February 1977 (UCA). Shade tree of coffee plantation.

SCROPHULARIACEAE

Castilleja arvensis Schlecht. & Cham. Atwood A154, 15 May 1975 (MSC). Local in disturbed area of elfin forest.

Schlegelia parviflora (Oerst.) Monachino. Atwood 7747, 3 February 1977 (FSU, MSC). Common elfin forest tree.

SIMAROUBACEAE

Picramnia teapensis Tulasne. Neill 1399, 8 February 1977 (MO). Lower cloud forest.

SOLANACEAE

Cestrum aurantiacum Lindl. Atwood A354, 10 July 1975 (MSC). Shrub at Plan de las Flores.

C. cf. racemosum R. & P. Atwood 77110, 8 February 1977 (MSC). Tree of lower cloud forest.

Jaltomata procumbens (Cav.) J. L. Gentry. Neill 988, 3 October 1976 (UCA). Lower cloud forest.

Physalis cordata Mill. Neill 998, 3 October 1976 (MSC). Weed of lower cloud forest.

Solanum americanum Mill. Robbins 6263, 1 August 1972 (MO).

S. canense Rydb. Neill 1567, 14 March 1977 (MSC). Deciduous forest.

S. nigrescens M. & G. Narvaez 3927, 27 January 1970 (MO). Disturbed areas in cloud forest.

S. torvum Sw. Atwood A38, 29 April 1975 (MSC). Disturbed area near vacation house.

Witheringia cf. meiantha (Donn.-Sm.) A. T. Hunziker. Atwood A58, 30 April 1975 (MSC). In disturbed cloud forest.

W. solanacea L'Herit. Atwood A59, 30 April 1975 (MSC). Disturbed areas near vacation house.

STERCULIACEAE

Byttneria aculeata Jacq. Neill 774, 19 September 1977 (UCA).

Melochia nodiflora Sw. Dudgey & Moore 1953, 9 January 1969 (VT).

Sterculia apetala (Jacq.) Karst. Atwood & Neill AN76, 2 July 1975 (MSC). Deciduous forest tree.

THEACEAE

Freziera friedrichstaliana (Szysz.) Kobuski. Atwood A166, 15 May 1975 (MSC). Elfin forest component. Known only from Honduras and Volcán Mombacho.

TILIACEAE

Apeiba tibourou Aubl. Atwood & Neill AN215, 16 July 1975 (MSC). Deciduous forest inhabitant.

Heliocarpus donnell-smithii Rose. Baker 2490 (MSC). Reported by Lay (1949).

H. nodiflorus Donn.-Sm. & Rose. Oersted 14829. Cited by Lay (1949). Tree of secondary growth.

Luehea sp. Baker 2311 (MSC). Probably in deciduous forest.

Triumfetta dumetorum Schlecht. Dudgey & Moore 1955, 9 January 1969 (MO). Cloud forest.

ULMACEAE

Trema micrantha (L.) Blume. Neill 1366, 3 February 1977 (FSU). Deciduous forest tree.

UMBELLIFERAE

Eryngium foetidum L. Robbins 6259, 1 August 1972 (MO). Common in disturbed areas of lower cloud forest.

Spananthe paniculata Jacq. Atwood 5474, 9 April 1971 (MO). Lower cloud forest in disturbed areas.

URTICACEAE

Fleurya aestuans (L.) Gaud. Dudgey & Moore 1975, 9 January 1969 (MO). Common herb in coffee plantations.

Urera sp. Not collected but common in coffee plantations.

VALERIANACEAE

Valeriana scandens var. *candolleana* (Gard.) Muell. Atwood A47, 30 April 1975 (MSC). Weed of coffee plantations and disturbed cloud forest on north flank.

VERBENACEAE

Cornutia grandiflora (Schlecht. & Cham.) Schau. Atwood & Neill AN79, 2 July 1975 (MSC). In deciduous forest areas at Finca Las Delicias.

Lantana glandulosissima Heyek. Dudgey & Moore 1958, 9 January 1969 (VT).

L. maxima Hayek. Seymour 6104, 25 July 1972 (MO). Lower cloud forest.

L. trifolia f. *hirsuta* Moldenke. Atwood A355, 10 July 1975 (MSC). Roadside in lower cloud forest.

Lippia cardiostegia Benth. Nelson 7510, 8 August 1976 (MO). Lower cloud forest.

L. controversa var. *brevipedunculata* Moldenke. Atwood A202, 14 May 1975 (MSC). Collected on north flank of Mombacho above Finca Asunción.

Priva lappulacea (L.) Pers. Dudgey & Moore 1983, 9 January 1969 (MO). Cloud forest weed.

VIOLACEAE

Hybanthus attenuatus (Humb. & Bonpl.) G. K. Schulze. Atwood & Neill AN73, 2 July 1975 (MSC). Common in upper deciduous forest and lower cloud forest.

VITACEAE

Vitis tiliifolia Humb. & Bonpl. Sterile vines observed in lower cloud forest areas, south side of Mombacho.

ZINGIBERACEAE

Renanthera aromatica (Aubl.) Griseb. *Atwood, Marshall & Neill* 6711, 15 December 1973 (MO). Only one plant found in elfin forest.

LITERATURE CITED

- ALVAREZ DEL CASTILLO, C. 1976. Estudio ecologico y floristico del crater del Volcan San Martin Tuxla. Thesis. Universidad Nacional Autonoma de Mexico, Mexico.
- AMES, O. 1923. New or noteworthy orchids. *Schedulae Orchidiana* 6: 36.
- . 1924. Additions to the orchid flora of tropical America. *Schedulae Orchidiana* 7: 7.
- Allgemeine Deutsche Biographie. 1878. Duncker and Humblot, Leipzig. Volume 8: 68.
- BAYNTON, H. W. 1969. The ecology of an elfin forest in Puerto Rico. Part 3. *J. Arnold Arbor.* 50: 80–92.
- BEARD, J. S. 1942. Montane vegetation in the Antilles. *Caribbean Forest.* 3: 61–74.
- . 1944. Climax vegetation in tropical America. *Ecology* 25: 127–158.
- BROWN, W. C. 1919. The vegetation of Philippine mountains. The relation between environment and physical types at different altitudes. *Bur. Sci. Publ., Manila*, 13.
- CATTELL, J. M. 1906. *American Men of Science—A Biographical Directory.* Edition 1. The Science Press, New York.
- CHAUDHRI, M. N., I. H. VEGTER & C. M. DE WAL. 1972. *Index Herbariorum.* Part II(3). *Regnum Veg.* 86.
- CRABBE, J. A., A. C. JERMY & J. T. MICKEL. 1975. A new generic sequence for the pteridophyte herbarium. *Fern Gaz.* 11: 141–162.
- CRAWFORD, I. 1902. List of the most important volcanic eruptions and earthquakes in western Nicaragua within historic times. *Amer. Geol.* 30: 111–113.
- CRONQUIST, A. 1968. *The Evolution and Classification of Flowering Plants.* Houghton Mifflin Company, Boston.
- GILL, A. M. 1969. The ecology of an elfin forest in Puerto Rico. Part 6. *J. Arnold Arbor.* 50: 197–209.
- GOYENA, M. R. 1909, 1911. *Flora Nicaraguense*, Volumes 1, 2. Managua.
- HEMSLEY, W. B. 1887. *Biologia Centrali-Americana.* Appendix: a sketch of the history of the botanical exploration of Mexico and Central America. *Botany* 4: 117–137.
- HOWARD, R. A. 1968. The ecology of an elfin forest in Puerto Rico. Part 1. *J. Arnold Arbor.* 49: 381–418.
- . 1969. The ecology of an elfin forest in Puerto Rico. Part 8. *J. Arnold Arbor.* 50: 225–267.
- INCER, J. 1973. *Geografia ilustrada de Nicaragua.* Libreria y Editorial Recalde, S. A. Managua.
- KOBUSKI, C. E. 1941. Studies on the Theaceae, 8. A synopsis of the genus *Freziera*. *J. Arnold Arbor.* 22: 471–472.
- LAY, K. K. 1949. A revision of the genus *Heliocarpus*. *Ann. Missouri Bot. Gard.* 36: 507–541.
- MANTICA, C. 1973. *El Habla Nicaraguense.* Educa, San Salvador.
- MELINA, A. 1975. Enumeracion de las plantas de Honduras. *Ceiba* 19: 1–118.
- MOOSER, F., H. MEIJER-ABICH & A. R. MCBIRNEY. 1958. Catalogue of the active volcanos of the world including solfatara fields. Part 6. International Vulcanological Association, Napoli.
- OBERLANDER, G. T. 1956. Summer fog precipitation on the San Francisco Peninsula. *Ecology* 37: 851–852.
- STANDLEY, P. C. & L. O. WILLIAMS. 1961. *Flora of Guatemala.* Part 7. *Fieldiana, Bot.* 24: 30.
- STEENIS, C. G. G. J. VAN. 1972. The mountain flora of Java. E. J. Brill, Leiden.
- STRAHLER, A. N. 1973. *Introduction to Physical Geography.* John Wiley & Sons, Inc., New York.
- TWOMEY, S. 1957. Precipitation by direct interception of cloud water. *Weather* 12: 120–122.
- VOGELMANN, H. W. 1973. Fog precipitation in the cloud forests of eastern Mexico. *BioScience* 23: 96–100.
- , T. SICCAMA, D. LEEDY & D. C. OVITT. 1968. Precipitation from fog moisture in the Green Mountains of Vermont. *Ecology* 49: 1205–1207.



Atwood, John T. 1984. "A Floristic Study of Volcan Mombacho Department of Granada, Nicaragua." *Annals of the Missouri Botanical Garden* 71, 191–209.
<https://doi.org/10.2307/2399063>.

View This Item Online: <https://www.biodiversitylibrary.org/item/54734>

DOI: <https://doi.org/10.2307/2399063>

Permalink: <https://www.biodiversitylibrary.org/partpdf/3942>

Holding Institution

Missouri Botanical Garden, Peter H. Raven Library

Sponsored by

Missouri Botanical Garden

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.